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BMP Retrofit Pilot Program

OPERATION MAINTENANCE AND MONITORING PLAN DISTRICT 7

VOLUME I -GUIDANCE FOR PREPARING SITE SPECIFIC PLANS

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1.0 INTRODUCTION

1.1 Scope and Purpose of Program

The Caltrans Best Management Practice (BMP) Retrofit Pilot Program is a comprehensive water quality monitoring study to evaluate the constituent removal efficiency, technical feasibility, and costs of constructing and maintaining Best Management Practices (BMPs). The program will include detailed records of siting, design, construction, and operational and maintenance issues and problems. A significant result of the program will be a benefits assessment program including detailed documentation of the process of designing, building, operating, and maintaining each of the retrofit devices. The primary focus will be on documenting operational problems and procedures, determining solutions to such problems, and on documenting operational procedures that promote or maintain the effectiveness of the BMP, thus allowing Caltrans to develop accurate cost estimates for potential statewide BMP deployment.

This volume provides guidance for the preparation of site-specific BMP Operation, Maintenance and Monitoring (OMM) procedures for monitoring and assessing benefits resulting from implementation of selected stormwater treatment devices into portions of existing Caltrans drainage systems in Los Angeles County District 7. Specific procedures for inspection and maintenance, vector control, health and safety, storm monitoring, and program documentation will be developed according to the guidelines in this document.

Caltrans has undertaken projects in District 7 at sites selected based on technical evaluations; sites were chosen relative to appropriateness to the BMPs to be evaluated. Primary emphasis is on sites within a target watershed as defined in *Retrofit Pilot Program Scoping Study* (RBF, 1998*)* and *Composite Siting Study*, *District 7* (RBF, 1998).

General project criteria are:

- Determine the feasibility of design, construction and maintenance of the selected BMPs.
- Evaluate the performance and potential benefits of the selected BMPs in removing a wide range of constituents of concern in highway stormwater runoff.
- Evaluate the frequency and magnitude of operational problems associated with maintenance of the structures and maintenance and safety concerns specific to transportation facilities.
- Identify operational problems and suggest solutions.
- Document procedures that were determined to be beneficial or detrimental in maintaining the effectiveness of each BMP.

Table 1.1 List of BMP Projects Under Stipulation

Site	District	BMP Type	Project/Site No.
1. I-5 Manchester Ave	11-S	Extended Detention Basin	PRJ1#1
2. I-5 /Palomar Airport Rd.	11-S	Biofiltration Swale	PRJ1#3
3. Carlsbad MS	11-S	Biofiltration Strip/Infiltration Trench	PRJ2!1,2
4. SR-78/Melrose Dr.	11-S	Biofiltration Swale	PRJ2#3
5. I-5/La Costa Ave. Blvd.	11-S	Infiltration Basin	PRJ3#2
6. Escondido MS	11-S	Media Sand Filter	PRJ5#2
7. I-5/SR-78 P&R	11-S	Media Sand Filter	PRJ5#3
8. I-5/La Costa Ave. Blvd. P&R	11-S	Media Sand Filter	PRJ5#3
9. Kearney Mesa MS	11-S	Perlite-Zeolite Filter	PRJ5#4
10. I-21- East of Orcas Ave.	7-S	Continuous Deflective Separation Unit	PRJ1A#1*
11. 210 East of Filmore St.	7-S	Continuous Deflective Separation Unit	PRJ1A#1*
12. I-605/SR91 Interchange	7-S	Infiltration Basin	PRJ1#1
13. Altadena MS	7-S	Biofiltration Strip and Infiltration Trench	PRJ3#1,2
14. I-605/SR-91 Interchanges	7-S	Biofiltration Strip and Swale	PRJ3#5
15. Cerritos MS	7-S	Biofiltration Swale	PRJ3#4
16. I-51/I-605	7-S	Biofiltration Swale	PRJ3#4
17. I-605/Del Amo Ave.	7-S	Biofiltration Swale	PRJ3#7
18. Foothill MS	7-S	Biofiltration Swale	PRJ3#8
19. Las Flores MS	7-S	Drain Inlet Insert	PRJ3#9
20. Rosemead MS	7-S	Drain Inlet Insert	PRJ3#10
21. I-5/I-605/SR-91 Intersection	7-S	Extended Detention Basin	PRJ2#12
22. I-605/SR-91 Intersection	7-S	Extended Detention Basin	PRJ2#2
23. Alameda MS	7-S	Oil/Water Separator	PRJ4#
24. Eastern Regional MS	7-S	Media Sand Filter	PRJ4#2
25. Foothill MS	7-S	Media Sand Filter	PRJ4#2
26. Termination P&R	7-S	Media Sand Filter	PRJ4#3
27. Paxton P&R	7-S	Media Sand Filter	PRJ4#4*
28. Via Verde P&R	7-S	Multi-Chambered Treatment Train	PRJ4#8
29. Metro MS	7-S	Multi-Chambered Treatment Train	PRJ4#7*
30. Lakewood P&R	7-S	Multi-Chambered Treatment Train	PRJ4#6

*Project placed on contingency schedule

Complete records of design, construction, operation, maintenance and monitoring will be kept as a part of the pilot program and will be presented in a final report describing the feasibility, performance and operational characteristics of the projects.

The devices selected for evaluation in the pilot program will be designed, installed, operated, and maintained at state-of-the-art levels (what is considered to be the best technology and/or practice available to-date). The document, *Operation, Maintenance and Management of Stormwater Management Systems* (Watershed Management Institute and the United States Environmental Protection Agency, August 1997) has served as a primary guide and reference for the development of the maintenance and operation program defined in this manual.

Criteria used in selecting sites for the BMP Retrofit Pilot projects include:

- Hydraulic proximity to sensitive receiving waters
- Potential for improvements in water quality, including without limitation water quantity effects
- Technical feasibility
- Integration with other scheduled activities
- Cost effectiveness

1.2 Research Objectives

The BMP Retrofit Pilot Program is being undertaken to evaluate the constituent removal efficiency, technical feasibility, and costs of designing, constructing and maintaining specific BMPs at specific sites and to assess the benefits of the program. Solutions to problems identified will be recommended and implemented where possible.

1.3 Programmatic Requirements

The BMP Retrofit Pilot Program is being implemented in response to United States District Court, Southern District of Stipulation Order, (Civil Action No. 93-6073-ER(JRX)) directing the California Department of Transportation (Caltrans) to complete construction and post-construction monitoring of structural BMPs and determine whether and to what extent it is appropriate to implement these BMPs at existing rights-of-way. Plaintiffs are the Natural Resources Defense Council (NRDC), and the Santa Monica Baykeeper, and Terry Tamminen.

1.3.1 Governing Documents and Regulations

Retrofit Pilot Program Scoping Study, RBF, May 1998
Composite Siting Study, District 7, RBF, May 1998
Composite Siting Study, District 11, RBF, May 1998
Federal Clean Water Act, 33 U. S. C.
California Water Code, Division 7 (Porter-Cologne Act)
Caltrans Storm Water Quality Handbooks, Construction Staff Guide, 1996
Caltrans Storm Water Quality Handbooks, Construction Contractors Guide and Specifications, 1996
Caltrans Storm Water Quality Handbooks, Planning and Design Staff Guide, 1996
Water Quality Control Plan for the Los Angeles Basin (Region 4)
Water Quality Control Plan for the San Diego Basin (Region 9)
Operation, Maintenance and Management of Stormwater Management Systems, Watershed Management Institute and USEPA, August 1997
California Health and Safety Code, Civil Code, Food and Agricultural Code, and Code of Regulations listed in Appendix C1. Health and Safety Code Sections 2270-2294
United States District Court, Southern District of California Stipulation Order, Civil Action No. 93-6073-ER(JRX)

1.3.2 Federal Stormwater Programs

The primary regulation for the District 7 Stipulation Order is the Federal Clean Water Act. Various federal programs, including the Clean Water Act, may require the implementation of stormwater management programs by states, regional, or local governments, or require the implementation of stormwater BMPs by property owners.

1.3.3 State Stormwater Management Programs

The BMP Retrofit Pilot Program is being implemented in conformance with the general water quality objectives in the Water Quality Control Plan for the Los Angeles Basin (Region 4) and San Diego Basin (Region 9). All Region 4 and 9 water quality objectives satisfy the applicable requirements of the federal Clean Water Act and the California Water Code, Division 7 (Porter-Cologne Act). This act defines water quality objectives and beneficial uses as:

The limits or levels of water quality constituents or characteristics which are established for the reasonable protection of beneficial uses of water or the prevention of nuisance within a specific area. (Section 13050(h))

and

Beneficial uses of the waters of the state that may be protected against quality degradation include, but are not necessarily limited to: domestic, municipal, agricultural and industrial supply; power generation; recreation; aesthetic enjoyment; navigation; and preservation and enhancement of fish, wildlife, and other aquatic resources or preserves. (Section 13050(f))

1.3.4 Jurisdictional Issues

During the site planning process it was determined that none of the BMP locations impact jurisdictional waters of the U.S., including special aquatic sites (i.e., wetlands) per the Clean Water Act. These determinations were made by specialists, subcontracted to the consultants, using EPA/USACOE guidelines. However, in certain cases jurisdictional authority can extend to manmade features that exhibit wetland characteristics. The Army Corps of Engineers (ACOE) defines wetlands as areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. To determine if an area is a jurisdictional wetland, the Army Corps of Engineers looks at vegetation, hydrology and soils. The California Department of Fish and Game (CDFG) requires the presence of at least one of these three criteria in order to classify an area as a wetland. The ACOE requires the presence of all three elements (hydric soils, saturation, and hydrophytic plants). Where the use for which the manmade feature was created has ceased, and where the feature has taken on wetland characteristics, and where those characteristics are likely to continue in the absence of modifications to the feature, jurisdiction is likely to be asserted.

1.4 Schedule/Cost

A master schedule has been prepared indicating the timeline for retrofit siting, design, construction bid, construction, monitoring, and final report. (See Appendix B of the *Scoping Study*.) Under this 4-yr schedule, monitoring will begin in Fall 1998 for all BMP Retrofit Projects and continue for 3 yr. During the fourth year, a final report, including benefits assessment, will be prepared for submittal to the California State Water Resources Control Board or the Regional Water Quality Control Board, Los Angeles Region, whichever oversees Caltrans District 7's current stormwater permit at that time. In addition, a retrofit report although not formally a part of the BMP Pilot Retrofit Program, will be provided to the Regional Water Quality Control Board as a summary report for the District 7 Retrofit Pilot Program. A second or contingency schedule has

been developed indicating monitoring beginning in Fall 1999 rather than Fall 1998. The target schedule allows for two monitoring seasons, while the contingency schedule covers one monitoring season. Both schedules are consistent with the Stipulation Order requirements. If some pilot projects are delayed due to unforeseen circumstances, monitoring will proceed according to the contingency schedule. Caltrans and Plaintiffs to the Stipulation Order will jointly determine at established decision points which pilot projects will proceed under the contingency schedule. The decision points are defined as: (1) Upon completion of design and (2) Prior to the start of monitoring. A formal staging plan defining the decision points and the criteria used to review the specific pilot project schedule track at each decision point is included Appendix D of the *Scoping Study*.

A detailed project calendar has been prepared to track the: (1) major decision points defined in the *Scoping Study*; (2) deliverables to the Plaintiffs; and (3) delivery and response dates for work items to the Plaintiffs. The detailed project calendar is regularly updated and forwarded to Caltrans, NRDC, and Santa Monica Baykeeper weekly

OMM costs for the program will be accumulated during the course of monitoring. The OMM costs will be reported in the retrofit pilot project final report. The projects were constructed through bid packages and are being operated by consultants.

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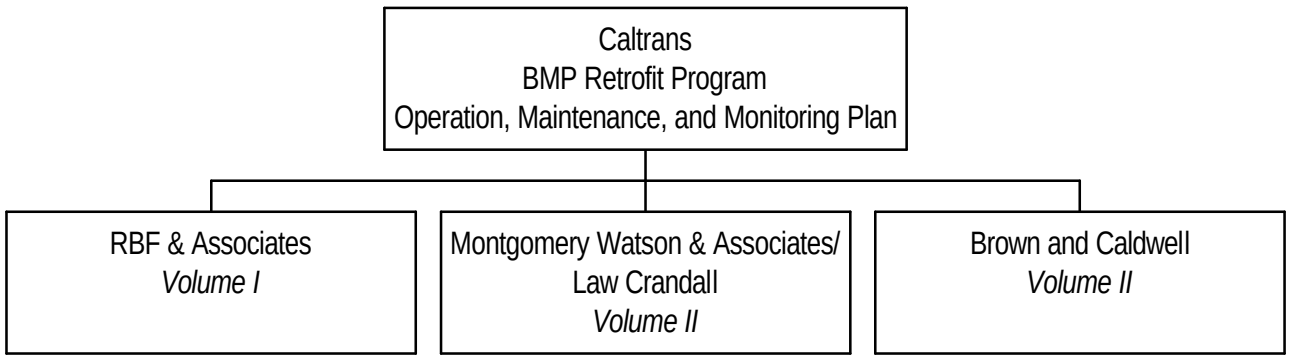
1.5 Organization of the OMM Plan

The OMM is separated into two volumes. Volume I is a guidance document for the preparation of Volume II, the site-specific BMP OMM procedures. Robert Bein, William Frost and Associates (RBF) is responsible for preparing Volume I. Volume II is being prepared by Montgomery Watson and Associates/Law Crandall (MW/LC) and Brown and Caldwell (BW). MW/LC and BW are responsible for operating, maintaining, and monitoring the District 7 BMPs

Figure 1.1 Organization of the OMM Plan



This volume of the OMM plan is organized into five subject areas. Sections 2.0, 3.0, and 5.0 provide guidelines for the technical aspects of the program. Health and safety issues are included in Section 4.0, and the required and suggested supporting documentation is listed in Section 6.0. General topics are shown in Table 1.2.

Table 1.2 General Topics

Section	Topic
2.0	**Operation and Maintenance**
	• Governing regulatory and programmatic requirements
	• Site-specific maintenance program development
	• Construction and post-construction inspection
	• Inspection and maintenance after construction
	• Training for operation and maintenance personnel
3.0	**Vector Control Management**
	• Applicable laws and regulations
	• Vector and pest monitoring
	• Vector control strategies
4.0	**Health and Safety**
	• Worker safety
	• Traffic safety
5.0	**Monitoring, Sampling and Analysis Plan**
	• Constituent selection
	• Selection of sampling methods and equipment
	• Equipment installation and maintenance
	• Laboratory sample preparation and analytical methods
	• Empirical observations
6.0	**Program Documentation**

Supporting documentation for each section is included in appendices referenced in those sections – i.,e Section 2.0/Appendix B; Section 3.0/Appendix C, etc. Since Section 1.0 requires no supporting documentation, there is no Appendix A. The components of this plan are discussed in greater detail in their respective sections; however, the basic operations and/or functions of each element of the plan are briefly discussed here.

Section 2.0 Operation and Maintenance

The objective of this manual is to ensure the necessary maintenance and management of the Caltrans Stormwater Pilot Retrofit BMPs.

Inadequate maintenance of stormwater management systems not only leads to reduced performance but may create conditions that are worse than if the facility had not been constructed. For example, a neglected dam may fail and release impounded water onto downstream properties; an eroding swale may be a source of excessive sediment; or a poorly managed constructed wetland may release harmful levels of nutrients or elevate downstream receiving water temperature.

Standards for stormwater system inspection and maintenance must conform to the requirements of the District 7 Stipulation Order and existing agency and government regulations concerning safety, maintenance and maintenance access, disposal of materials, removal of vegetation and preservation of flood control system capacity (*Operation and Maintenance of Stormwater Management Systems,* 1997).

Stormwater management systems have evolved from conveyance devices to systems that transport and disperse stormwater runoff safely and efficiently. Concern over nonpoint source (NPS) pollution, flooding, and erosion has resulted in the evolution of modern stormwater systems that not only convey runoff but also manage it by modifying flow rate, volume, and/or water quality. These stormwater management systems rely on practices such as infiltration or retention areas, extended dry or wet detention basins, filters, vegetated swales, and constructed wetlands.

Today's stormwater systems are much more complex than traditional conveyance-only systems and require a much greater level of effort in design, construction, and maintenance and management. Although maintenance has always been vital to the effective performance of stormwater systems, it is especially so to the successful performance of today’s modern systems. Some reasons for this increased importance are:

- The complexity of modern stormwater management is not only in function or operation but of the numbers and types of materials used to construct them.

- Many stormwater practices achieve management goals through impoundment or storage of runoff, either temporarily or permanently, instead of conveyance, through the use of dams, berms, tanks, or chambers. Increased levels of strength and safety required mean a similarly

increased level of maintenance.

- Traditional stormwater conveyances and flood control systems are designed to transport or impound the runoff from relatively rare storm events, i.e., 25 to 100 yr, and are thus subject to maximum design conditions infrequently. By contrast, modern stormwater management systems intended to treat runoff and reduce pollutants and designed to capture smaller, more frequent rainfall/runoff may experience maximum design conditions several times a year. This more frequent and repetitive operation at design limits creates more stress, which again demands greater attention and commitment to proper maintenance and management.

Section 3.0 Vector Control

Mosquito and vector control are issues of concern in southern California metropolitan areas. Structures that create standing water present opportunities for vectors and other disease-carrying pests to establish themselves and potentially spread diseases. Organisms that pose the greatest threat for spreading vector-borne diseases are mosquitoes and vertebrates such as rats, ground squirrels, skunks, and opossums. Additionally, burrowing rodents such as ground squirrels, gophers, and voles can damage BMPs that have earthen slopes and floors. The rapid increase in population in the area and the subsequent addition of new sources of standing water into a historically dry region creates the potential for disease transmission by mosquitoes and other organisms that can inhabit stormwater drainage systems, treatment wetlands, and nearly any unmanaged source of standing water.

For these reasons, once the retrofit projects were constructed and in operation, mosquito and vector control procedures were developed. A vector control specialist will collaborate in the preparation of a program to address operation and maintenance procedures to minimize vector problems at the BMP sites.

The monitoring program will include abatement procedures, if necessary. and will define appropriate abatement procedures (if any are required) Plaintiffs will be updated relative to vector monitoring activities through biweekly reports as well as participate in the formulation of the program.

Both water control and vegetation management are important to the vector control program. Proactive vegetation management – one method of reducing the presence of vectors – is, however, considered a maintenance function and is discussed in Section 2.0.

Section 4.0 Health and Safety

A major consideration throughout the BMP Retrofit Pilot Program will be promoting and maintaining safe work practices through written procedures that control potential physical and/or environmental hazards at the various BMP sites.

A hazard is any existing or potential condition in the field which, by itself or by interacting with other variables, can result in injuries, property damage, and other losses.

- A hazardous condition does not have to exist at all times to be classified as a hazard when the situation is being evaluated.

- A hazardous condition may not result from independent failure of workplace components but from one BMP site component acting upon or influencing another.

In any maintenance and monitoring activity, personnel, equipment, and materials interact within the BMP site environment in assessing maintenance requirements and collecting field samples. By consciously reviewing traffic and worker safety policies and procedures, personnel can conduct the maintenance and monitoring activities in the safest possible manner.

All consultants are responsible for health and safety plans for each site for which they are responsible. Guidelines for preparing these health and safety plans are given in Section 4.0 and in Appendix D of this volume, which contains the Caltrans *Code of Safe Operating Practices (July* 1991), and Chapter 8, "Protection of Workers" [revised June 1999] of the *State of California Department of Transportation, Maintenance Manual, Volume 1, (June 1998).* At a minimum, these plans will include emergency procedures and contact information. Special attention should be paid to traffic and worker safety.

Section 5.0 Sampling and Analysis

BMP performance will be evaluated based on water quality monitoring and empirical observations. Guidelines for water quality monitoring and empirical data collection are provided in Section 5.0. Stormwater samples for the appropriate BMPs will be collected to conduct post-construction analysis of the BMP performance.

The stormwater BMPs will be monitored to determine their effectiveness in removing a wide range of constituents present in highway runoff. Stormwater samples will be analyzed for the levels of solids, heavy metals, nutrients, and TPH (total petroleum hydrocarbons) present; samples from other more specialized controls will be analyzed for the appropriate subsets of these constituents.

The crucial task of weather forecasting includes projecting the amount of precipitation forecast for an impending storm event along with the expected duration of the storm. For the BMP Retrofit Pilot Program, this information is necessary (1) to determine whether the storm will produce sufficient runoff to permit collection of meaningful samples and thus whether to mobilize crews for sampling a storm event; and (2) to program certain sampling equipment to collect samples at appropriate intervals so as to not under-fill or over-fill the composite bottles, based on the rainfall/runoff amounts expected during the course of the storm.

As stated in the Stipulation Order, the wet or "rainy" season in southern California is from October 1 through April 30. Forecast information will be gathered as indicated in Section 5.0 (i.e. Internet sources). Some useful sources of weather information that can be used to track incoming storms include:

Source	Internet Address or Telephone Number
National Weather Service web page	www.nws.fsu.edu http://nimbo.wrh.noaa.gov/ Oxnard
Weather Watch Service	(619) 223-8163
Continental Weather and Earth Sciences, Inc.	1-800-THE RAIN
Alert system from Los Angeles County	http://www.nwsla.noaa.gov
The Weather Channel and local news stations	Cable TV; broadcast TV
Radar and satellite images downloaded from Internet sources	The Weather Channel - www.weather.com The Weather Underground - www.wunderground.com Weather - www.intellicast.com

During the wet season when the stormwater monitoring program is active, the monitoring task manager or field coordinator or designee (as designated by the respective consultants) will continuously track weather conditions and potential storms. Stormwater samples for the appropriate BMPs will be collected to conduct post-construction water quality studies. Stormwater samples will be collected from up to four storms per year, weather permitting, with a maximum of eight storms over a 2-yr period. The exception is the extended detention basin at the I-15/SR-78 interchange where 10 storms will be monitored over a 2-yr period. Storms that have intermittent periods of rainfall will be monitored only during rainfall periods that are not separated by more than a 2-hour period without rainfall. Storms targeted for sampling will be separated by a minimum of 48 hr.

Monitoring teams will be deployed based on the rainfall requirements needed to generate monitorable flows in and out of the pilots. The deployment criteria defines when to chase storms based on season, storm forecasts, and the current count of successfully monitored storms.

The deployment season, in which monitoring teams remain "on-call" and fully staffed, will be restricted to the portion of the year when rainfall is most probable and better predictable. Summer showers are not seen as predictable events. Dry watersheds and BMPs will retain more water, which results in less effluent.

The deployment season will start on October 1 and will end after 3 weeks of dry weather where less than 0.2 in. of rainfall occurs in Los Angeles County but no sooner than April 1 and no later than May 31. This approach accommodates wet or dry springs.

The following criteria decreases false starts, while allowing teams to continue to chase storms based on promising storm forecasts. The criteria should be used for all pilots, regardless of drainage area size or land use. A forecast of 0.25 in. of rain is one of the two prerequisites for a monitoring crew to mobilize for a storm. The second prerequisite is that the forecast is predicted with at least a 50 percent probability. If the probability is less than 50 percent and a forecast of less than 0.25 in. of rain (unlikely forecast), crews do not mobilize. If the probability of this prediction is 50 percent or greater but less than 75 percent (marginal forecast) the decision regarding mobilization is at the discretion of Caltrans. If the probability is 75 percent or greater (probable forecast) then crews must mobilize. Caveats to the above criteria, e.g., a forecast with less than 0.25 in. of rain and a greater than 50 percent probability, are at the discretion of Caltrans.

Twelve aliquots, 75 percent capture and 0.1 in. of rain will serve as general criteria for defining a successfully monitored event. However, it will be at the discretion of Caltrans to make the final determination on whether an event was successful.

When deployment criteria is satisfied and paired samples are successfully obtained for any storm larger than 0.1 in., the sampling would potentially be considered as a successful event, which would potentially count towards fulfilling *Scoping Study* requirements.

The determination of which events will be considered successfully monitored (counting towards the total number of monitored storms required for each BMP) will be based on professional judgement. Most successful events will involve a minimum of 12 aliquots (samples), 75 percent capture and a minimum of 0.1 in. of rain. However, in some cases as few as 8 aliquots and 50 percent capture will be sufficient, and in some cases 0.1 in. of rain will be insufficient to trigger proper BMP functioning.

Once a specific pilot is successfully monitored for the total required storms per the *Scoping Study*, the decision to further sample that particular pilot will be deferred to Caltrans. No commitment to monitor beyond the terms of the *Scoping Study* can be made at this time.

Section 6.0 Documentation

Section 6.0 describes the documentation process relative to the pilot projects. An analysis of the data collected during inspection, maintenance, and monitoring will form a central part of the final report. Emphasis in the final report will be on identifying solutions to problems discovered during the implementation of the pilot projects, and documenting procedures that were determined to be either beneficial or detrimental in maintaining the effectiveness of the BMP.

Detailed records will be maintained for each site to document siting, design, construction, operation and maintenance experience. Many of the stormwater BMPs that will be monitored during this program, have been the subject of numerous research efforts. Consequently, the constituent removal for some of these devices is well-established for properly designed and maintained systems. Therefore, much of the effort of this program will be directed to recording and analyzing the siting, design, construction, and operation and maintenance experience. Forms will be developed for each phase of the project and will be used in support of the benefit assessment program and report which will be integrated into the final report.

As specified in the Stipulation Order, the benefits assessment program will be guided by the following criteria:

- Hydraulic proximity to sensitive receiving waters
- Potential for improvements in water quality, including without limitation water quantity effects
- Technical feasibility
- Integration with other scheduled activities
- Cost effectiveness

Emphasis in the final report will be on identifying solutions to problems discovered during the implementation of the pilot projects, and on documenting procedures that were determined to be beneficial in maintaining the effectiveness of the BMP.

The Benefit Assessment Program for the pilot projects will include the following elements:

- Analysis of stormwater samples (influent and effluent) for each pilot project except as modified herein using autosampler equipment. Sampling results and site conditions will be described for each sampled storm event. This data will be compiled in a database and presented in the final report.

- A review of the maintenance program to determine that each pilot project has been maintained at state-of-the-art levels and that improper m,aintenance has not impaired the operation of the BMP.

- An assessment program documenting: the deviations from standard design; compromises in design-based, on-site constraints; and deviations from standard maintenance practices due to unusual weather, site conditions or failures.

- Results of observation of BMP operation during storm and post storm, assessing such factors as: functioning of the outlet works; estimation of residence time, visual observations regarding 'short circuiting;' and drain time for infiltration BMPs

- Comparison of the performance of the pilot projects to that of other BMPs in similar projects, analyzing the reasons for differences where they occur

- Documentation of the complete process including siting, design, construction and monitoring in a final report.

2.0 OPERATION AND MAINTENANCE

2.1 Governing Regulatory and Programmatic Requirements

Governing regulatory and programmatic requirements include the governing plan documents, federal and state stormwater management programs. These are listed and/or discussed in detail in Section 1.0.

2.2 Maintenance Program Development

The maintenance program requires two sequential tasks: (1) inspection to ensure that construction has been satisfactorily done; and, (2) maintenance to sustain the site in an operational condition and to correct problems noted during inspection.

Each BMP site will be visited after every storm event to inspect and perform functional maintenance. Prior to the beginning of the BMP monitoring period (October 1 through April 30) each site will be visited to determine its readiness for monitoring the storm events. During these site visits, it will be decided what, if any, actions are needed to achieve or maintain the intended operational performance.

2.3 Construction Inspection

Inspection responsibilities during construction include routine inspections and activity-specific inspections. Routine inspections are required in order to monitor the progress of the project development and to assess the quality of construction. It also ensures that the developer or contractor is aware of the inspector's presence on site.

At least two site inspection forms will be used: one on the first visit to assess the general site conditions; and the second for site corrections or compliance according to an administrative order for all visits thereafter. (See Appendices B-1 and B-2 of this volume for sample inspection checklists and Volume II for BMP-specific checklists.)

In addition to periodic routine inspections, regular progress meetings will be held to discuss action timetables, problems, and needed changes, and to assure coordination between the designer, contractor, and inspector.

Specific activity inspections will be performed during the sensitive construction phases. These phases generally include specific BMP construction design guidelines that may require extra supervision from someone who is more familiar with the procedure. Examples of this may include preparing the basin floor for the infiltration basin, or implementing vegetative cover for the

biofilter, etc.

Final inspection will be done prior to the contractor demobilization. Any incomplete items associated with the stormwater management facilities should be detailed and provided to the contractor and developer. Final inspections should proceed until all deficient items have been remedied.

The devices that are most susceptible, are the ones that have biological components or that require infiltration as part of the process as described below.

Extended Detention Basins/Wet Basins

- Ensure that all slopes within the immediate basin area have been stabilized prior to prior to final basin construction.

Biofiltration Devices

- Ensure that a temporary flow diversion channel has been constructed during the period when vegetation is being established.
- Inspect sod strips for large gaps or patches that need attention to ensure proper growth establishment.
- Check the irrigation layout to ensure 100% coverage of the biofilter for the dry periods.
- Check that excess leaves and sediment in the surrounding area have been eliminated.
- Check that overhanging trees and bushes that cast large shadows over the biofilter have been pruned to allow the proper amount of sunlight.

Infiltration Trench/Basin

- Before construction begins, make sure the entire draining area to the facility has been stabilized. If not, place a diversion berm around the BMP site to prevent entry of sediment.
- Designate a maintenance access area for the movement of heavy vehicles as to protect the infiltration zone.
- Make sure all excavated material is placed at least 10 feet away from the infiltration zone.
- Inspect the bottom and side walls of the facility for any protruding objects that may puncture the filter fabric like tree roots. (trench)
- After final grading, ensure that trench bottom soil has been deeply tilled to provide a well-aerated, highly porous surface texture.
- Filter fabric should be rolled to overlap from the upstream end to the downstream end.
- Place a sign stating the facility and its purpose and prohibiting walking or use a vehicle on the surface which could compact it, or litter or yard waste in or near it.

Media Filters

- Tributary area should be stabilized if possible to protect facilities from too much sediment.

- Large trees and bushes should be pruned to protect the facilities from accumulating leaves.

2.4 Post-Construction Inspection

Once construction is completed, consistent inspection and maintenance is needed to assure the facility will operate as originally designed. To ensure thorough and consistent inspection measures, a comprehensive inspection checklist must be provided. It is essential that all operation and maintenance activities be documented since this will later be used to evaluate the overall efficiency and performance of each BMP.

2.4.1 Inspection Frequency

The frequency of both inspection and maintenance depends on how much and how often it rains, and the potential for large storm events. Climate provides is one of the foundations upon which stormwater management systems are designed and constructed. The characteristics of storms, such as rainfall intensity, depth, inter-event time, and percentage of annual precipitation as snow or rain, are also important factors in determining inspection frequency. The recommended time frames for inspection and maintenance will vary depending on local climate and rainfall conditions.

Southern California's defined wet and dry seasons impact the inspection and maintenance required, especially practices for which inspections/maintenance are recommended monthly. During a normal wet season, inspections should be done according to the recommended schedule. However, during a normal dry season monthly, more frequent, inspections may be necessary to manage non-stormwater flows, mosquitoes, and other things which may affect the future performance of the BMPs.

In addition to the seasonal rainfall and vegetation-growing seasons, the dormant seasons will have an impact on how often a biofiltration BMP will need to be inspected. The dormant season may provide a good opportunity to inspect a facility for erosion problems due to a winter die back of the

vegetation. Areas that could not be inspected during the growing season may be visible when the vegetation dies back.

Simply stated, the more rainfall events and the greater the pollutant loading, the more work a

stormwater management facility must do. Increased use or loading is directly related to the need for maintenance. Inspections may be needed more frequently in areas having a greater number of storms and greater storm magnitudes.

2.4.2 Checklists for Inspectors

Generic inspection checklists for each type of BMP are located in Appendix B-2 and further refined in Volume II of this manual to reflect site-specific conditions.

Facility tracking and recording are important components of the stormwater facility maintenance programs. Computer data bases must be used that will allow inspectors to be assigned an inventory of facilities to inspect and provide easily accessible information on when OMM was done last and when the next inspection may be needed. The data entered into the computer tracking system will include identification numbers for each facility (project and site number), facility type, facility locations, special maintenance needs, and data from previous inspections. At the conclusion of each site visit, the inspector will enter a maintenance needs assessment into the computer database.

This will help ensure that problems are corrected in the order of the risk that they pose. This type of system will also ensure that no facilities "fall through the cracks" in terms of inspections and maintenance. Tracking of when a facility was last inspected and the facility's status should never be dependent on the memory of an individual inspector.

2.5 Maintenance

Detailed maintenance checklists for each type of BMP are located in Volume II. The maintenance indicator document (MID), Appendix B-3 of this document, includes specific maintenance tasks and frequency.

The maintenance function can be divided into two categories: aesthetic and functional. These two categories can overlap at times and are equally important. Functional maintenance is important for performance and safety reasons, while aesthetic maintenance is important for public acceptance of

stormwater facilities and because it may also reduce needed functional maintenance activities. Both forms of maintenance are needed, and both must be combined into an overall stormwater management system maintenance program.

2.5.1 Aesthetic Maintenance

Aesthetic maintenance enhances the visual appearance and appeal of a stormwater facility; an attractive facility can become an integral part of a community. Aesthetic maintenance is obviously more important for those facilities that are visible. Above-ground, open-air facilities obviously need more aesthetic maintenance than underground stormwater systems. Thus, it is

generally more important at basins and biofiltration facilities, although it may also be important for certain types of filtration and infiltration facilities. The following tasks constitute aesthetic maintenance:

- **Removal of trash and debris** - A regularly scheduled program of debris and trash removal will reduce the potential for outlet structures, trash racks, and other facility components from becoming clogged and inoperable during storm events. In addition, removal of trash and debris will prevent possible damage to vegetated areas and eliminate potential mosquito breeding habitats. Disposal of debris and trash must comply with all local, county, state, and federal waste control programs. Only suitable disposal and recycling sites should be used.

- **Graffiti Removal** - Timely removal of graffiti will improve the appearance of a stormwater system also tends to discourage further graffiti or other acts of vandalism.

- **Grass Trimming** - Trimming grass around fences, outlet structures, and along hiker/biker paths and structures obviously makes for a more attractive appearance. As much as possible, the design of stormwater facilities should incorporate natural landscaping that is lower maintenance.

- **Weed Control** - Where vegetation has been established, weeds or undesirable plants are to be expected. "Undesirable" includes woody species or any species that has grown larger than that specified in the guidelines (i.e., 6 in.). These undesirable plants can impact the aesthetics of a stormwater facility and can also invade wetland stormwater systems and wet detention littoral zones.

- **Miscellaneous** - Careful, meticulous, and frequent attention to such maintenance tasks as painting, tree pruning, and leaf and debris collection and removal will keep a stormwater management system attractive and help maintain its functional integrity.

2.5.2 Functional Maintenance

Functional maintenance is necessary to keep a stormwater management system operational at all times. Functional maintenance has two components:(1) preventive maintenance, and (2) corrective maintenance.

- ***Preventive maintenance*** is performed on a regular basis and includes maintaining moving parts, such as drain valves, locks, maintenance of vegetative covers to prevent erosion, mowing grass and maintaining other vegetation, removing trash and debris, removing and disposing of sediment, maintaining mechanical components, and vector control.

- ***Corrective maintenance*** is required on an ad-hoc basis as a result of operational problems that may be encountered. Corrective maintenance includes removal of debris and sediment, structural repairs, dam embankment and slope repairs, vector elimination, erosion repair, fence repair, vegetation and animal burrow elimination.

2.5.2.1 Preventive Maintenance

Functions such as mowing grass, trimming trees, trash and debris removal, and removing graffiti are areas in which aesthetic and functional maintenance overlap (see para. 2.5.1). More specific to functional preventive maintenance are:

Sediment Removal - Accumulated sediment should be removed before it threatens the operation or storage volume of a stormwater management system. Disposal of sediments is discussed in para. 2.8 and must comply with local, county, state, or federal requirements. Only suitable disposal areas should be used. Sediment removal in infiltration systems must also include monitoring the porosity of the sub-base, replacing or cleaning the pervious materials as necessary, and reestablishing vegetation.

Mechanical Components - Valves, sluice gates, pumps, fence gates, locks, and access hatches should remain functional at all times. Regularly scheduled maintenance should be performed in accordance with the manufacturers' recommendations. All mechanical components should be operated during each maintenance inspection to assure continued performance.

Mosquito and Vertebrate Control - Methods of vector control are discussed in Section 3.0. However, vegetation control and identifying burrowing animals are part of the maintenance program (see para. 2.10). The most effective mosquito control program is one which eliminates potential breeding habitats, or, in the case of open-water basins or wetlands, ensures that optimal conditions are maintained for the survival of mosquito control organisms. Any stagnant pool of water can become a mosquito breeding area within a matter of days. Standing water that persists for longer than 3 to 7 days will be drained except for the wet basin where standing water is a

design feature. Efforts to eliminate standing water that is present beyond the requirements for water quality improvements and that poses a threat for vector production should be made by direct intervention (i.e., use of sump pumps, submersible pumps, drainage, etc.) if necessary. Burrowing animals can present problems for dams or embankments and may create habitat for sensitive species. The root system of woody vegetation can undermine dam or embankment strength and are harder to maintain. If the vegetation dies and the root system decomposes, voids can be created in the dam or embankment which weaken the structure. Preventive maintenance can avoid this problem.

2.5.2.2 Corrective Maintenance

General corrective maintenance should address the overall facility and its associated components. If algae growth becomes a problem for basins or if an infiltration facility does not totally drain, steps must be taken to reestablish the original performance of the system. Stormwater facilities are complex systems and will work only as long as each individual element functions correctly. If corrective maintenance is being done on one facility component, other components should be inspected to determine if corrective maintenance is needed. There may be cost savings in conducting maintenance activities on several components at the same time if equipment is available on site which could serve several maintenance items.

Failure to promptly deal with a corrective maintenance problem can jeopardize the performance and integrity of the entire facility or system. The purpose of corrective maintenance is to restore the effective and safe operation of the stormwater management system. Corrective maintenance activities may include but are not limited to:

Removal of Debris and Sediment (*see para. 2.8)* - Sediment, debris, and trash that threaten the ability of the facility to store or convey water must be removed and disposed of immediately. A blocked inlet or outlet means that stormwater will travel in an area that was not designed as a flow path. In the case of an inlet, the stormwater could flow over a curb onto a grassed area; if an outlet is blocked, water can back up and travel through the emergency spillway or overflow area was were not designed for frequent flow and can become eroded. If sediments are clogging a facility component, the lack of an available disposal site should not delay removal of the sediments. Temporary arrangements should be made for handling the sediments until a more permanent arrangement is made.

Structural Repairs - Repairs to any structural component of the facility should be made promptly. Equipment, materials, and personnel must be readily available to perform repairs on short notice. The immediate nature of the repairs depends on the type of damage and its effects on the safety and operation of the system. Where structural damage has occurred, the design and conduct of repairs should be undertaken only by qualified personnel.

Dam, Embankment and Slope Repairs - Typical problems include settlement, scouring, cracking, sloughing, seepage, and rutting. A concern in an embankment with a barrel assembly or outflow pipe through it is seepage around the outside of the barrel. This can also cause movement of embankment soils, which can weaken the embankment. Repairs need to be made promptly. Other temporary activities may be needed, such as drawing down the water level in the facility to relieve pressure on a dam or embankment, or to facilitate repairs. Crack repair in a concrete structure may necessitate draining the facility and cleaning the area of the crack prior to repair. If the facility is to be dewatered, pumps may be necessary if there is no drain valve.

Animal/insect control - Corrective action may be needed if it is determined that the stormwater facility is the source of a mosquito or animal problem. If mosquitoes become a problem, control experts should be consulted for advice. (See Section 3.0.) Animal burrows should be filled and steps taken to remove the animals if burrowing problems continue. If the problem persists, local wildlife officials should be consulted regarding removal steps because of the threat of disease or injury and the possibility that animals may have to be destroyed rather than relocated.

Erosion Repair - Vegetative cover is necessary to prevent soil loss and to maintain the structural integrity of the facility and its pollutant removal benefits. Where a reseeding program has been ineffective or where other factors have created erosive conditions (i.e., concentrated flow, etc.), corrective steps should be taken to prevent further loss of soil and any subsequent danger to the performance of the facility. Corrective action may include but is not limited to erosion control blankets, riprap, sodding, or reduced flow through the area. Local experts should be consulted to address erosion problems if the solution is not evident.

Security Device Repair - Fences, locks, and other security devices can be damaged by a number of factors, including vandalism and storm events. Timely repair will maintain the security of the site.

2.6 BMP-Specific Maintenance

Listed below is a summary of the maintenance procedures for each BMP. Maintenance procedures specific to each BMP site will be developed and presented in detail in Volume II. The maintenance indicator document (MID) which governs tasks and frequency is included in this volume as Appendix B-3.

2.6.1 Extended Detention Basins

Periodic removal of sediments will be required to maintain the basin stormwater capture volume and to remove undesirable or excessive vegetation growth. Maintenance access to the basin invert will be provided for this purpose. The outlet structure and debris rack should also be inspected prior to each storm event.

- Sediment removal or sediment management
- Erosion repair, including vegetative stabilization
- Maintenance of storm monitoring equipment
- Grass mowing/trimming and removal of cuttings
- Replant vegetation
- Structural repairs
- Road maintenance
- Graffiti removal
- Vector harborage inspections
- Endangered species inspections
- Clean flumes and/or cracks in stormwater conveyance system
- Embankment/slope repairs
- Maintenance of fences, gates, locks, and enclosures
- Vegetation trimming and tree pruning
- Weed control
- Animal /insect control
- Debris and trash removal
- Painting
- Burrowing rodent activity inspections

2.6.2 Infiltration Basins and Trenches

Infiltration basins must be periodically cleaned to remove trapped sediments and restore permeability. Over the course of operation, fines will accumulate on the basin invert creating a relatively impervious veneer that reduces the average infiltration rate. The deposits must be removed from the basin when the infiltration time for the design storm volume exceeds 72 hours. Vegetation must also be managed to prohibit excessive amounts that would reduce the stormwater volume, moderate vegetation is generally seen as a positive attribute for infiltration devices as it can aide in maintaining permeability of the soil and assist in the uptake of some soluble constituents.

2.6.2.1 Infiltration Basin

- Slope and embankment repair; drainage areas kept stabilized
- Vegetative stabilization/replanting
- Weed control
- Removal of standing water
- Grass mowing/trimming and removal of cuttings
- Painting
- Endangered species inspections
- Sediment/erosion control
- Clean orifices and/or cracks in stormwater conveyance system
- Animal/insect control
- Maintenance of fences, gates, locks, and enclosures
- Graffiti removal
- Drain time evaluation
- Vector harborage inspection
- Burrowing rodent inspections

2.6.2.2 Infiltration Trench

The infiltration trench will be monitored via the observation well to ensure that acceptable permeability is maintained over the life of the project. The trench must be completely drained within 72 hours. Maintenance of the trench would entail removal of the gravel matrix and the filter fabric, and replacement of these components.

- Removal of top layer of stone aggregate
- Weed control
- Removal of standing water
- Grass mowing/trimming and removal of cuttings
- Painting
- Replacement of top layer of stone aggregate and/or filter fabric
- Animal/insect control
- Maintenance of fences, gates, locks, and enclosures
- Graffiti removal
- Vector harborage inspections
- Burrowing rodent inspections

2.6.3 Biofiltration Strips and Swales

Biofilters require maintenance of the vegetation including limiting the height of the growth to about 6 in. and ensuring good coverage. Standing water must be eliminated through regrading or sediment removal and debris must be removed from the surface areas. Any condition that promotes the concentration of flow across a strip-type biofilter must be corrected.

- Sediment removal from level spreader and strip
- Clean orifices and/or cracks in stormwater conveyance system
- Slope and embankment repair
- Animal/insect control
- Maintenance of fences, gates, locks, and enclosures
- Graffiti removal
- Residence time assessment
- Slope and embankment repair
- Erosion repair, including vegetative
- stabilization
- Weed control
- Removal of standing water
- Grass mowing/trimming and removal of cuttings
- Burrowing rodent inspections
- Endangered species inspections

2.6.4 Media Filters

General maintenance practices will include ensuring that the vaults are free from debris that would otherwise block discharge. The filter surface must be maintained to ensure that flow can pass through the media at the design rate. As with infiltration BMPs, a veneer of sediment will accumulate on the media which must be periodically removed.

The media filter must be maintained regularly to assure that sediment accumulation does not impede the filtration capacity. Maintenance needs vary from site to site based on the type of land use activity, implementation of source controls, and weather conditions. Perlite/Zeolite filters shall be inspected quarterly or at a frequency recommended by the manufacturer, Stormwater Management. Inspection and maintenance of media filters shall include:

2.6.5 Sand Filter

- Sediment removal
- Check inlet/outlet channels, grating, etc.
- Animal/insect control
- Maintenance of fences, gates, locks, and enclosures
- Graffiti removal
- Filter loading assessment
- Burrowing rodent inspections
- Check sump pumps
- Weed control
- Removal of standing water
- Grass mowing/trimming and removal of cuttings
- Painting
- Vector harborage inspections

2.6.6 Oil/Water Separators

The OWS acts as physical separator of oil and water. Oil and water enter the OWS and immediately the flow velocity is slowed to allow for the settling of solids. Coalescing plate separators act as means for oil droplets to collide and agglomerate and thus become larger globules. These larger globules rise rapidly to the oil water interface, where separated oil accumulates. The coalescing of oil droplets results in an increased rate of efficiency of oil separation.

The operational and maintenance needs of an OWS are:

- The OWS should be filled with water at all times
- Wastewater containing a high dissolved solids concentration must be excluded
- Monitoring of the OWS for oil levels
- When spills occur at the Maintenance Station, quickly take care of all spills with absorbent or spill kits to prevent overloading the OWS
- Exclusion of detergents and solvents, their presence retards the recovery of oil
- Periodic hydrocarbon and sediment removal to optimize performance
- Monitoring of the OWS for sludge buildup
- Removal of all debris
- Preventive maintenance on monitoring equipment.

2.6.7 Multi-Chambered Treatment Trains

The MCTT includes a catch basin/grit chamber followed by a two-chambered tank that is intended to reduce a broad range of toxicants. The runoff enters the catch basin chamber by passing over a flash aerator (small column packing balls) to remove highly volatile air components, if present, and to capture large debris. This catch basin also serves as grit chamber to remove the largest particles.

The operational and maintenance needs of an MCTT are:

- Periodic sediment removal to optimize performance
- Replacement of the filter fabric when needed
- Preventive maintenance on monitoring equipment
- Replacement of the media when needed
- Removal of all debris

2.6.8 Continuous Deflective Separation (CDS) Units

The CDS technology captures and retains floatables, trash, and debris greater than 0.05 in. in stormwater runoff, as well as fine sand and larger particles and the pollutants attached to those particles. The CDS unit is a non-mechanical self-operating system and will function when there is flow in the storm drainage system. The unit is designed to capture pollutants in flows up to the design capacity (1.1 cubic feet per second) and during extreme rainfall events when the design capacity may be exceeded. Material captured in the CDS unit's separation chamber and sump is retained even when the unit's design capacity is exceeded.
e operational and maintenance needs of a CDS are:

- Inspection of its structural integrity and its screen for damage
- Periodic sediment removal to optimize performance
- Removal of graffiti
- Erosion and structural maintenance to maintain the performance of the CDS
- Animal and vector control
- Scheduled trash, debris, and sediment removal to prevent obstruction of a CDS and monitoring equipment
- Preventive maintenance on sampling, flow measurement, and associated BMP equipment and structures

2.6.9 Drain Inlet Inserts

The operational and maintenance needs of a DII are:

- Animal and vector control
- Periodic sediment removal from the Fossil Filter™ to optimize performance
- Trash and debris collection and removal to prevent obstruction of DII and monitoring equipment.
- Preventative maintenance on sampling, flow measurement, and associated BMP equipment and structures.
- Periodic replacement of the StreamGuard™ insert and its absorbent material to optimize performance
- Periodic replacement of the Fossil Filter's™ adsorbent material to optimize performance
- Removal of graffiti

The maintenance requirements for DIIs were compiled from product information and discussions with the DII vendors and/or manufacturers

2.7 Equipment, Resources and Tools Needed

A number of tools are used in the maintenance of stormwater management systems, and actual equipment and material requirements should be determined individually for each facility. However, listed in Tables 2.1 and 2.2 are suggested lists of equipment, resources, and tools needed for inspection and maintenance.

Materials

- Topsoil
- Fill material
- Seed
- Mulch
- Paint
- Paint removers (for graffiti)
- Spare parts for equipment
- 0il and grease for equipment and stormwater management facility maintenance of mechanical components
- Concrete

Table 2.1 Equipment Needed for Maintenance

Task	Equipment Needed
Grass maintenance	Tractor-mounted lawn mowers; riding lawn mowers; hand mowers; gas powered trimmers; gas powered edgers; seed spreaders; dethatching equipment; grass clipping and leaf collection equipment
Vegetative cover maintenance	Saws, pruning shears, hedge trimmers, wood chippers
Transportation	• Trucks for transporting materials and equipment • Vehicles for personnel transportation
Removal of debris, trash, and sediment	Loader, backhoe, grader, dragline, vacuum equipment
Miscellaneous equipment and resources	• Shovels, rakes, picks, wheel barrows, fence repair tools, painting equipment, gloves, standard mechanics tools, tools for maintaining maintenance equipment • Office space, office equipment, telephone, • Safety equipment • Tools for concrete work (mixers, form materials, etc.)

Adapted from *Stormwater Management Facilities Maintenance Manual*, " (NJDEP, 199).

Table 2.2. Equipment Needed for Inspection and Maintenance

During Routine Maintenance Inspection	On Site during Maintenance of a Stormwater Facility
• Flashlight • Locke level or survey equipment • Approved facility plans • Measuring rod (to determine depth of sediment accumulation) • Crowbar (removal of cast iron covers) • Inspection report form • Pen or pencil • Encroachment permit[(1)]	• Gloves • Safety hat • Safety glasses • Safety boots • Inspection report form • Pen or pencil • Lock level or survey equipment • Approved facility plans • Encroachment permit

Adapted from *Stormwater Management Facilities Maintenance Manual* (NJDEP, 1989).
(1) An encroachment permit is required for each site that lies within Caltrans right of way. A blanket permit has been acquired for all sites within District 7.

2.8 Disposal of Stormwater Sediments

The stormwater pollutants that accumulate in the sediments often include several contaminants such as heavy metals, petroleum hydrocarbons, and other organic compounds, such as pesticides or solvents, which may be considered hazardous wastes.

The Resource Conservation and Recovery Act of 1976 (RCRA) requires generators of hazardous wastes to monitor and manage them in accordance with specified procedures. A solid waste may be considered a hazardous waste if it contains materials that are specifically listed in Sections 261.31 through 261.33 of 40 CFR, or because it possesses any of four hazardous characteristics (ignitability, corrosivity, reactivity, or toxicity). In nearly all cases concerning stormwater sediments, the reason that they may be classified as hazardous is that they contain chemicals listed in the above documents, rather than because the sediments are hazardous by characteristic. It is possible for stormwater sediments to be classified hazardous wastes because they exhibit toxicity if, using the Total Characteristic Leaching Procedure (TCLP), the extract contains contaminant concentrations which exceed the limits listed in Table 1 of Section 261.24 or 40 CFR.

In addition, all actions must comply with the Consent Order agreement established between Caltrans and the State Department of Toxic Substances Control (DTSC), Docket # HWCA 95/96-056. The debris and sediment will be treated as if they were one material. Thus debris and sediment can be stored and treated in the same manner.

Preliminary studies have indicated that accumulated wastes can surpass dangerous waste levels for several metals and petroleum hydrocarbons. A study by Herrera Environmental/Consultants (1991) found that vactor truck sediments generally exceeded the Washington Model Toxics Control Act criteria for polyaromatic hydrocarbons (PAHs) and total petroleum hydrocarbons (TPH). Concentrations of the most often detected compounds were greater in wastes from industrial areas than from residential and commercial areas.

Disposal of decant water, the liquid fraction of storm facility wastes removed from the BMP, also poses risks to water quality. Decant water has the potential to carry solids, metals, toluene, xylenes, and volatile and semi-volatile compounds. Total suspended solids (TSS) are a principal pollutant in street waste liquids. Many contaminants, particularly metals, bind to fine particles, organic material, and clay particles. Total Kjedahl nitrogen is associated with particles in the 250 to 2000 micron size range. Total phosphorus and nitrate-nitrogen bind to particles smaller than 100 microns, but most nitrate-nitrogen is in solution. Liquids can also contain large numbers of fecal coliform bacteria. Toluene, xylene, and ethyl-benzene are among the most frequently detected organic compounds in decant water. Illicit dumping and property owner practices can greatly increase contaminant concentrations in stormwater management facilities.

2.8.1 Recommendations on Sediment Testing

Maintenance personnel should examine the appearance and odor of solids and liquids removed from stormwater BMPs to determine whether chemical analyses are necessary. Personnel should be alert to an especially oily appearance, coloration by antifreeze, or odors of gasoline, solvents, hydrogen sulfide, or other noxious substances

Contaminated material should not be mixed with storage containing cleaner wastes. Mixing wastes of differing qualities could contaminate the whole load and make its disposal more difficult. The suspected hazardous waste should be analyzed to determine the appropriate disposal method.

Testing should be performed of all material and sediment removed from every BMP. Key analyses to determine sediment and sand disposal requirements are fats, oils, and grease (FOG), TPH, and the TCLP and other metals.

2.8.2 Recommendations on Disposal of Stormwater Sediments

Disposal recommendations depend on the maintenance method used for the waste sediment excavation. Disposal methods for a vactor truck, which pick up waste water in addition to sediment, will be different than disposal methods used for shoveling sediment.

Several methods for disposal exist depending on the concentrations of toxins in the waste. Methods can range from recycling to lined municipal landfills. If sediment is proven relatively clean, it can be used in asphalt, portland cement, pipe bedding (unless potable water), utility trench backfill, etc. if applicable to State Regulations.

At the time of disposal, if the wastes are deemed unfit for municipal landfill use, a full and comprehensive testing program should be run for all the constituents outlined under California State Regulations.

Decant water can be very saturated with pollutants and thus difficult to find a method of appropriate disposal. It is suggested that the maintenance contractors use sediment waste recovery methods that capture minimal amounts of wastewater. In the case that waste decant water is obtained and the liquids meet the specifications detailed in National Pollution Discharge Elimination System (NPDES) Permit #CAG994210, they are discharged to a preferably non-sensitive local storm drain system.

2.9 Caltrans Drain Inlet Cleaning Program

As a guide to the operation and maintenance personnel on how to collect, store and dispose sediment and other material accumulated in the BMPs, Caltrans method for drain inlet program may be used, where appropriate, as a model. This method was developed in accordance with a Consent Order between Caltrans and the State of California Environmental Protection Agency, Department of Toxic Substances Control Docket #. HWCA 95/96-056.

Sediments must be collected using a vactor truck that vacuums the sediments out of the drop inlets and other drainage structures. The sediments are then transported daily to designated sites and transferred to non-leaking roll-off bins. Daily records, or Bills of Lading must accompany each vacuum truck. Under Transportable Treatment Unit (TTU) Conditionally Exempt Permit #UPSDW1, the bins are dewatered by allowing liquids to settle-out through a TTU authorized filtration system. When the general storage bins are full, samples are taken by an analytical laboratory certified by the State of California to find out the degree of sediment contamination.

Registered transporters are used to ship any hazardous sediments from the sites to authorized hazardous wasted disposal facilities under standard California Uniform Hazardous Waste Manifests.

2.10 Vegetation Management

Each BMP must be maintained to address public health issues and to ensure effective BMP performance as well as being a good aesthetic neighbor. The public health issues encountered with vegetative BMPs are vector problems. Vectors such as mosquitoes, vertebrates, and roaches are potential disease carrying organisms.

2.10.1 Management for Optimal BMP Performance

Vegetation maintenance requirements for performance optimization varies depending on the BMP type and the vegetation type. Each BMP should be maintained whenever vegetation impedes the overall BMP performance. BMP's (e.g. salt grass in biofilter strips and swales will be maintained to a height of approximately 6 to 12 in.)

Hydraulic and constituent removal performance should also be considered in the maintenance program of detention basins, infiltration basins, and wet basins. Within the guidelines mentioned above, each BMP site should be properly maintained functionally and aesthetically. A customized maintenance program will be created that will describe the steps needed for proper care as well as at suggested frequencies (see Volume II).

Landscape maintenance for BMP sites should consider the type of landscape found in the surrounding area. In some cases, minimizing the cutting or trimming may be the most aesthetically and economically acceptable practice.

Biofiltration devices will only require weed maintenance, since the mature height of the plant species used is only about 12 in. Weed removal should be performed at minimum three times per year in the months of April, June, and August. Top growth and roots of weeds should be removed manually.

Natural vegetation growth that will be found in the infiltration basin, detention basins and wet basin should be maintained according to the suggestions in para.2.6.1 and 2.6.2.. At a minimum, vegetation should be maintained in the beginning and end of the wet season, i.e., October and April. Weed eradication personnel should be trained in the identification of weed species and desirable species.

2.10.2 Management for Optimal Vector Control

Effective proactive vegetation management strategies need to be developed in order to reduce likelihood of vector and nuisance insect production and the necessity of repeated insecticide applications. Operational procedures that reduce the likelihood of vector production lower the possibility that costly control measures requiring pesticides and insecticides/larvicides will be needed. If control measures are needed, they will need to consider factors such as BMP design, the vector species, the stage of the insect life cycle present, the time of the year, etc. Management strategies which provide source reduction should focus on two general areas: (1) control of water levels, and (2) vegetation management.

Water and vegetation management are critical to reducing the probability of the establishment of vector species. The most likely vectors anticipated at the BMPs are mosquitoes and vertebrates. Each species requires a specific strategy for water and vegetation management.

Mosquitoes and Midges - Vegetation in wetted areas can enhance the incidence of mosquitoes and midges by providing predators, a food source and protection from wind and waves. BMPs that do not have vegetation at the water surface tend not to have mosquitoes. Therefore, if water levels are reduced or eliminated over a period of one to three days, the potential for the production of mosquitoes will be reduced. Additionally, vegetation management can enhance the reduction of mosquito populations. Vegetation management can be accomplished in several ways. Controls include herbicide application, harvesting, and controlled burns. Each method has

its own drawbacks and opportunities. Additionally, vegetation management strategy will need to be adapted to each BMP technology and site. Section 3.0 is a detailed discussion of mosquito reduction including vegetation management.

Vertebrates - Vertebrate pests and vectors include primarily rats and ground squirrels. Vegetation at the BMP sites can provide food, nesting materials, and harborage to support populations within and adjacent to the planted areas. Selection of plant species which create lush and thick habitats should be avoided. Where vegetation and rodents are present, management of the plants may include mechanical removal and herbiciding. Employment of these two strategies is presented in Section 3.0.

2.11 Costs of Stormwater Facility Operation and Maintenance

Annual program budgets will include adequate staffing and financial resources to conduct the maintenance activities needed to assure that stormwater systems operate properly. Additionally, the stormwater program must assure that financial mechanisms are implemented to provide the needed funding.

Costs for stormwater system OMM is very site specific. Factors that determine the frequency, type, and costs of OMM include the type and size of BMP, use of source controls, land use, contributing drainage area, rainfall characteristics, climate, vegetation growing system, maintenance access, and disposal requirements.

Due to the length of time for this program, renting equipment and contracting of services will be used. The consultants will develop detailed cost estimates based upon local data or data pertaining to a specific program or type of stormwater system. Valuable information can be obtained from local government stormwater, public works, parks, or road departments.

Other costs include labor estimates and disposal of wastes. Table 2.3 is a list developed by US EPA. Which gives some possible cost ranges for equipment and materials:

Table 2.3. Cost Estimates and Ranges Maintenance Items

GRASS MAINTENANCE EQUIPMENT		
EQUIPMENT	PURCHASE	RENT (Per Day)
Hand mower	$300-500	$25-50
Riding mower	$3,000-7,000	$75-150
Tractor mower	$20,000-$30,000	$150-450
Trimmer/edger	$200-500	$25-30
Spreader	$100-200	$20-30
Chemical sprayer	$200-500	$25-40
VEGETATIVE COVER MAINTENANCE EQUIPMENT		
Hand saw	$15-20	$5
Chain saw	$300-800	$15-35
Pruning shears	$25-40	$5
Shrub trimmer	$200-300	$25-35
Brush chipper	$2,00-10,000	$100-300
SEDIMENT, DEBRIS, AND TRASH REMOVAL EQUIPMENT		
Vactor Truck	$100,000-250,000	$700-1200
Front end loader	$60,000-120,000	$250-500
Backhoe	$50,000-100,000	$250-500
Excavator	>$100,000	$400-1,000
Grader	>$100,000	$400-1,000
TRANSPORTATION EQUIPMENT		
Van	$18,000-30,000	$50-100
Pickup truck	$15,000-25,000	$50-100
Dump truck	$40,000-80,000	$100-200
Light duty trailer	$3,000-6,000	$50-100
Heavy duty trailer	$10,000-20,000	$100-250
MISCELLANEOUS EQUIPMENT		
Shovel	$15	$5
Rake	$15	$5
Pick	$20	$5
Wheel Barrow	$100-250	$15-25
Portable compressor	$800-2,000	$50-150
Portable generator	$750-2,000	$50-150
Concrete mixer	$750-1,500	$50-100
Welding equipment	$750-2,000	$50-100

Table 2.3 (continued)

MATERIALS	
MATERIAL	PURCHASE
Topsoil	$35-50/cubic yard
Fill soil	$15-30/cubic yard
Grass seed	$5-10/pound
Mulch	$25-40/cubic yard
Dry mortar mix	$5/50 pound bag
Concrete delivered	$60-100/cubic yard
Machine/motor lubricants	$5-10/gallon
Paint	$20-40/gallon
Paint remover	$10-20/gallon
Note that the costs shown are expected to be, with some variation, the costs Caltrans will incur.	

Costs for facility maintenance will be recorded as a part of the documentation of the retrofit pilot program. The recorded costs will be compared to published costs, such as those indicated in above, and differences discussed.

Facility tracking and recording are important components of stormwater facility maintenance programs. A database will be developed that identifies each site, the date and time of the site visit, and records all maintenance and costs for each visit. Monitoring costs will be kept separate from normal BMP operating and maintenance costs.

2.12 Training

Training programs for both inspection and maintenance personnel will be mandatory and will be the responsibility of individual consultant companies. Individuals responsible for maintenance of and operation of stormwater management systems seldom have that job as their primary responsibility. They need basic education about stormwater management systems, their operation, and maintenance.An inspector must know what components of a stormwater management facility are integral to proper function and safety. The same is true for maintenance personnel but with less emphasis in some areas. The focus of the training program will be on matters directly applicable to OMM situations.

2.12.1 Inspector Training Program

The program must include classroom or lecture sessions and a program manual. The course curriculum will include but not be limited to the following components:

- Institutional background for the stormwater management program and why stormwater facilities are important for stormwater quantity and quality control

- Basic soils and geology information

- Basic hydrology and hydraulics so inspectors have an understanding of the processes involved in rainfall and runoff

- Specific legal authority and regulatory requirements of the stormwater management program including inspection requirements and penalty options

- Different types of stormwater management facilities, treatment processes of the individual facilities and the maintenance issues associated with each type of facility

- The impacts of maintenance on water quality, including disposal of waste material

- How to read plans and understand specifications

- How to inspect a stormwater management facility, including use of maintenance inspection checklists

- Case studies showing construction and maintenance of stormwater management facilities; construction techniques and sequences so inspectors will understand the importance of components that are not normally visible

- Issues related to actual maintenance of stormwater management facilities; disposal of materials removed from the facility and concerns regarding the hazardous nature of removed sediments
- Identification of weed species and desirable species of plants

2.12.2 Maintenance Training Program

The program must include classroom or lecture sessions and a program manual. The course curriculum will include but not be limited to the following components:

- Why stormwater facilities are important for stormwater quantity and quality control

- Specific legal authority and regulatory requirements for the maintenance of stormwater management systems; the obligations associated with facility ownership

- Different types of stormwater management facilities being used; the treatment processes of the individual facilities and the maintenance issues associated with each type of facility
- Impacts of maintenance on water quality, including disposal of waste material.
- How to read the plans and understand appropriate specifications
- The use of maintenance checklists
- Actual maintenance of stormwater facilities, including disposal of materials removed from the facility and concerns regarding the hazardous nature of removed sediments

3.0 VECTOR MANAGEMENT

3.1 Applicable Laws, Regulations, and Agreements

Laws and regulations that govern or relate to mosquito and vector control in California are found principally in the sections of the California Health and Safety Code, Civil Code, Food and Agricultural Code, and Code of Regulations listed in Appendix C-1. Health and Safety Code Sections 2270-2294 describe "District Powers"(Appendix C-2).

Caltrans has developed a Service Agreement with each Vector Control District (VCD), Health Department, or equivalent agency. The documents establish the responsibilities of Caltrans, the VCDs and Health Departments with regard to vector management at each BMP site.

3.2 Vector and Pest Monitoring

Structures that create standing water present opportunities for vectors to establish themselves and potentially spread diseases. The organisms that pose the greatest threat for spreading vector-borne diseases are vectors such as like mosquitoes and vertebrate hosts such as rats, ground squirrels, skunks and opossums. The program for monitoring and controlling vectors is described subsequently.

Agreements with the vector control agencies have been executed; the agencies will conduct the monitoring and abatement of insect vectors. The following sections are presented for the understanding of those involved with that monitoring and abatement service. If future stormwater projects require vector monitoring and abatement, this section may serve as guidance for developing vector-related programs.

Appendix 4 of Volume II presents a summary of actions that must be performed for vector control. Appendix 4 has become the primary reference for actions to be taken under the vector agreements.

3.2.1 Mosquito and Midge Monitoring

3.2.1.1 Adult Sampling

Adult mosquitoes and midges will be sampled according to the protocols described *in Vector Control Background Monitoring Plan, District 11* and its sister document for District 7. Two types of traps will be used, the carbon dioxide (CO_2) light traps and gravid traps. Each type of

trap will be run for one night each week at each BMP location from April until October and for one night biweekly from November through March, coinciding with the activity of mosquitoes in southern California. The gravid trap and CO_2-light trap can be placed in proximity since they sample different components of adult mosquito population. Detailed information on the efficacy and use of these traps is included in Appendix C-3.

3.2.1.2 Larval Sampling - Mosquitoes and Midges

Larval surveys can determine the spatial and temporal use of a habitat by a particular mosquito species. Larval surveys can also determine the composition and density of a population. These data help decide which control measures are best and how effective they are.

Dipping is the most effective method of routine mosquito larval surveillance. Larval and adult surveillance data can evaluate whether sites other than those under consideration are sources of adult mosquitoes. For example, if, after effective control measures are carried out at a BMP, adult populations do not change or increase, it is likely that another site is producing adult mosquitoes.

An Ekman grab is most often used to sample midge larvae. The grab is dropped into soft substrate and the spring-loaded doors are closed by sending a weight down the line attached to the top of the grab. The mud sample is passed through a series of brass screens. The midge larvae can be picked from the sample after spreading it into an enamel or plastic pan. A second method is to elutriate larvae from solution using a density gradient of concentrated sugar. Both methods are quite labor-intensive as compared to sampling mosquito larvae.

3.2.2 Vertebrate Vector Monitoring

The design of the BMP and the degree of maintenance necessary will determine whether or not vertebrate vectors become a problem. Some sites may provide, forage, or other requirements for vertebrate vectors and may also offer short-term (72 hr) sources of drinking water. Monitoring will only be considered if preliminary findings indicate a need. These inspections will be initiated after the first winter storm season.

Some vertebrates are true vectors and transmit disease through bites or other close contact. Others that are considered vectors are actually hosts, and the agents that cause human disease are transmitted by their parasites. Table 3.1 lists some of these disease-bearing vertebrate vectors.

Table 3.1. Disease-Bearing Vertebrate Vectors

Source of Disease	Examples	Disease
True vectors	Bats, skunks, foxes, deer mice	Rabies, Hantavirus pulmonary syndrome, tularemia, Rocky Mountain spotted fever, leptospirosis
Parasites living on "host" vectors	Rodents (squirrels, chipmunks, mice, and wood rats	Plague, murine typhus, relapsing fever, lyme disease

The vertebrate vectors likely to be associated with the BMP Retrofit Pilot Project are listed in Table 3.2.

Table 3.2. Probable Vertebrate Vectors at BMP Projects

Domestic (Commensal) Rodents	Wild Rodents	Other Vertebrates
Roof rate *(Rattus raffus)*	Vole *(microtus spp.)*	Striped skunk *(Mephitis mephitis*
Norway *rat (Rattus novegifus)*	Wood rat *(neotoma spp.)*	Opposum *(Didelphis marsupialis*)
House mouse *(Mus musculus)*	Deer mouse *(peromyscus spp.)*	
	California ground squirrel *(spermophilus beecheyi)*	

3.2.3 Vertebrate Monitoring: Strategies, Methods, and Equipment

Monitoring small animals can be difficult due to terrain, their behavioral patterns, time constraints, the need for specialized equipment, weather, and other factors. For purposes of vertebrate vector monitoring, only observation techniques and trapping will be discussed as they relate to the habitat and probable species associated with the BMP Retrofit Pilot Program.

Observation can include:

- Visual sighting
- Burrowing/nesting activity
- Plant/structure damage
- Tracks/trails
- Fecal/urine deposits
- Odor
- Skeletal/skull identification

Live trapping is commonly used for both surveillance and control of vertebrate vectors. Traps should be placed and retrieved within 24 hr. A minimum of 20 traps are usually set at one time. Ground squirrels, skunks, opossums, rats, mice, voles, and other animals can be trapped with baited live traps placed near known habitats and runways. Some recommended traps and their dimensions are given in Table 3.3.

Table 3.3. Recommended Vertebrate Traps

Vertebrate Vector	Recommended Trap
Ground squirrels	• Tomahawk live trap 19”x 6”x 6”(48.3 x 15.2 x 15.2 cm) • Havahart live trap 18”x 5”x 5” (45.8 x 12.7 x 12.7 cm)
Rats (Norway rats, roof rate, and wood rats)	• Tomahawk live trap 16”x 5”x 5”(40.8 x 12.7 x 12.7 cm) • Havahart live trap 18” x 5”x 5” (45.8 x 12.7 x 12.7 cm) • Sherman live trap12”x 3”x 3 3/4”(30.4 x 7.6 x 9.5 cm)
Mice	• Havahart live trap 10”x 3”x 3”(25.4 x 7.7 x 7.7 cm) • Sherman live trap 9”x 3” x 3 ½”(22.9 x 7.6 x 8.9 cm)
Skunks/opossums	• Tomahawk live trap 20”x 7”x 7”(50.8 x 17.8 x 17.8 cm) • Havahart live trap 30”x 7”x 7”(76.2 x 17.8 x 17.8 cm)

Discussed here are vertebrates likely to be encountered at the BMP Retrofit sites and the methods and types of equipment that are most effective in monitoring.

Ground squirrels: Active in daylight hours, they are burrowing animals, and their activity can be determined by observing burrowing systems. Tracks and trails are less reliable but can confirm other indications of their presence. They are much less active in late fall, winter, and during the warmest parts of summer. Their home range is approximately 300 ft.

Equipment - A minimum of 20 live traps should be placed at least four times during the monitoring season. The traps should be set early in the morning, checked twice during the

day, and collected when full or during the same evening. Animals trapped are then identified as to species, weighed and measured, sexed, approximate age determined, euthanized, and data recorded. If the Regional Supervising Public Health Biologist, California Department of Health Services, Vector-borne Disease Section determines that it is necessary, blood and ectoparasite samples will be tested by the department's laboratory for the presence of disease.

Voles: Voles prefer habitats where there are abundant seeds, roots, and other forage. They connect their burrows with 1- to 2-in. wide runways through matted grass. They are chiefly diurnal but are seldom seen. Voles are extremely fecund, and their population is cyclic. They reach high population levels every 3 to 4 years, followed by a rapid decline the next breeding season. Voles are active year-round and their home range is 60 ft or less.

Equipment - To monitor voles, traps are placed as needed in the early morning and collected the same evening, over three consecutive days, repeated quarterly. Animals trapped will be identified to species, weighed and measured, sexed, appropriate age determined, and data recorded.

Norway Rats: Norway rats are usually associated with burrows adjacent to structures. These burrows can be seen, but tracks, gnawing marks, and rub marks from their fur can also indicate their presence. They are nocturnal, and sighting is not a reliable method of monitoring their populations. Their home range is typically 100 to 150 ft.

Roof Rats**:** Roof rats are excellent climbers and spend much of their time above ground. They prefer a vegetarian diet and are associated with dense vegetation. Roof rats may be detected by observing gnawing on fruit, trees, and other objects in their habitat. Roof rats are nocturnal and have oily fur which will frequently stain light-colored surfaces. The roof rat home range is usually at minimum 100 to 150 ft.

Equipment - Domestic rodents will be trapped on three consecutive trapping nights, repeated quarterly at each site where monitoring is necessary. Sites will be pre-baited two consecutive nights prior to being set. Traps will be placed as needed after pre-baiting in the evening and collected the next morning. On each of the three collection days, the animals caught will be identified as to species, weighed and measured, sexed, approximate age determined, and the data recorded.

3.3 Vector Control Strategies

The selection of an appropriate control strategy will be BMP-site specific. Source reduction, habitat modification and vegetation management are important components of the vector control program.

Appropriate maintenance of BMP sites is critical for long-term reduction of vertebrate vector population potential.

Habitat management is essential in order to reduce the production of vectors and nuisance insects and minimize the application of pesticides at BMP sites. Management strategies will focus on three general areas:

- Physical
- Biological
- Chemical

3.3.1 Physical Control

3. 3.1.1. Mosquitoes and Midges

Vegetation is crucial in physical control. Each BMP will provide its own vegetation management strategy; however, included here are considerations that must be taken into account in formulating vegetation control plans

Although vegetation control is primarily a maintenance function (see Section 2.0) One effective way to control vegetation is to *manage water:*

- Standing water will not persist more than 7 days in all BMP designs except for wet basins which require continuous flooding.
- If floodwater mosquitoes such as *Psorophora* spp. become problematic, the time period will be reduced to 3 days.
- Standing water that is beyond the requirements for water quality improvement will be removed immediately.
- Wet basins will be designed so the depth of water can be manipulated rapidly and effectively.

Standing water that contains vegetation and/or organic debris is a typical problem as is a habitat that is temporarily inundated. Shallow ponds with fluctuating water levels, partial drawdown of deep-water systems and complete drawdown of a wetland may create substrate that is the preferred breeding sites for certain species of mosquitoes. To prevent this, the sides of the BMP

must be almost vertical. Channels with steep sides that increase the water flow will reduce the likelihood that pools and marshy areas will develop (Service, 1980). Procedures that create depressions e.g., tire tracks that collect standing water in the basin floor will be avoided.

Partial drawdown is effective when mosquitoes are restricted to the periphery of a source (Collins and Resh, 1989). While augmenting water is successful at controlling the growth of bullrushes and cattails, it is not practical for stormwater control structures because the water supply is unpredictable.

Other forms of vegetation management include harvesting, controlled burning, and using herbicides**.** However, all of these have disadvantages which must be considered. Herbicides are not practical where water quality is the primary concern. Harvesting requires heavy, expensive equipment such as tractors, bulldozers, or amphibious/aquatic mechanical weed-harvesting equipment. If tractors or bulldozers are used, the BMP will be dry.

Burning mobilizes stored nutrients and pollutants and subsequent drying may destroy the litter and sediment layers. Burning adversely affects air quality and increases the potential for forest/brush fires. Winter rains can significantly limit the effectiveness of controlled burns. Ash and other residuals are likely to have a negative effect on water quality.

3.3.1.2 Vertebrates

Ground Squirrels: Any modification that discourages burrowing is helpful in controlling ground squirrels. Controlling the amount of vegetation and seeds used for food and nesting materials where possible is also recommended. As previously noted, small numbers of ground squirrels can be controlled with traps, described in paragraph 3.2.1. If ground squirrels become problematic, they may be poisoned by a licensed applicator. Poisoning can control ground squirrels for a year or more.

Rats: Removing harborage and food are the two most important steps in controlling rats. Norway rats are burrowers and feed on high protein food sources such as meat scraps and garbage. They require water daily. Roof rats live in lush vegetation, feeding on fruits and vegetables; they get much of their water from the foods they consume. Regular control of weeds and removal of debris near structures will reduce the amount of food and harborage.

Physical barriers are effective in preventing rodents from entering structures. All openings, including ventilation openings, larger than 1/4 in. should be sealed with material that rats cannot gnaw through. Burrowing near structures can be prevented by laying a strip of heavy gravel (at least 2 ft wide and 6 in. thick) around the perimeter of foundations or concrete slabs. To prevent roof rats from climbing trees, trunks can be banded with 18-in. wide bands of metal. Wires or pipes leading into trees or structures can be fitted with metal cone guards at least 20 in. in

diameter.

Rats may be trapped with baited snap traps placed where rats are most likely to come in contact with them, e.g., on runways, areas adjacent to vertical surfaces, near burrow openings and other travel routes. Pre-baiting with unset, baited traps is recommended for the first two or three nights. Bait should be replaced regularly. Do not use petroleum-based lubricants used to lubricate trap moving parts.

Voles: Removal of grass and seed on slopes is probably the only effective method of physically controlling voles. Controlling vegetation that provides harborage and/or food is an essential part of a comprehensive control program. Algerian ivy, bougainvillea, palm trees, bamboo, natal plum bushes, and other lush vegetation are sources of shelter and food. Grasses and grass seeds provide forage and nesting materials for voles and other small rodents. Vegetation will be removed entirely or thinned to the extent where it is no longer attractive as food or harborage.

3.3.2 Biological Control

Mosquitoes: The biological control agent most commonly used to control mosquitoes is the mosquitofish, *Gambusia affinis*. Mosquitofish are most effective in wet basins that have a depth of 4 to 12 ft and limited shallow shoreline (< 30% of surface area). Their effectiveness as a mosquito control agent declines as the density of vegetation increases.

Vertebrates: Biological control techniques for vertebrate vectors are not well studied. Habitat enhancement and protection for natural predators may help. These include hawks and owls, coyotes, bobcats, gopher snakes, foxes, weasels, and skunks.

3.3.3 Chemical Control

Mosquitoes: Vector control agencies prefer "biologically rational" compounds to control mosquitoes. In southern California, three types of pesticides are currently used against mosquito larvae: mosquitocidal oils, mosquito-specific bacteria and insect growth regulators. Details on the effectiveness and use of each of these is presented in Appendix C-3.

Midges: All efforts at controlling midges are directed towards larvae. When at least 300 larvae/ft^2 of substrate are observed, methoprene granules should be applied at a rate of no more than 10 lb/acre.

Vertebrates: Chemical control will be used in conjunction with physical control whenever possible. For rats and other rodents, the least dangerous rodenticides currently available are

multiple-dose anticoagulants, typically wax blocks or pellets which are placed in approved tamper-resistant bait stations near the rodent habitat and designed to allow the rodent access to the target. Second-generation anticoagulants require one feeding to produce the desired results. All bait stations and rodenticide containers must be properly labeled and they must be placed and monitored by trained staff.

3.3.4 Threshold Criteria and Treatment Guidelines

3.3.4.1 Mosquitoes and Midges

Measures to control mosquito larvae are initiated when one or more larvae or pupae are found at a BMP site.

Adult monitoring will indicate whether more larval sampling is necessary and will be compared to the baseline abundance and species for a given BMP site. If the number of adults is much greater than background levels, samples of mosquito larvae from the BMP site need to be obtained. Larval samples can be combined with adult surveillance data to evaluate whether adult mosquitoes are in fact coming from the BMP site or from another nearby location.

Certified staff from the responsible vector control district will control mosquitoes. The duration of control will depend on environmental factors, particularly the flushing rate. Larvicides must be applied according to the label. *Bacillus sphaericus* may be effective for 3 or more weeks (Siegal and Novak, 1997). Monitoring is critical during periods without rainfall. The evolution of resistance to this product is of concern. Rotation of larvicides will reduce the likelihood that the mosquitoes will develop resistance to *B. sphaericus*.

Insect growth regulators, i.e., methoprene can be applied as briquettes or in PVC units for season-long application, providing that rainfall occurs throughout the peak mosquito season and standing water is present for extended periods. Methoprene can also be applied as a "duplex formulation" with *Bti*.

Larvicidal oil will be used only when pupae are the predominant stage of mosquito found at a site. Oil is the least expensive pesticide, but is indiscriminate since it kills by suffocation. The impact of larvicidal oils on water quality is unknown. However, since this pesticide dissipates in 48 hr, its effect is thought to be minimal.

Pesticides will be applied only by properly certified staff of vector control districts or approved certified applicators. Whenever possible, the most specific and least toxic material will be used.

3.3.4.2 Vertebrates

If rodents are present or if there is evidence of rodent activity at a BMP, such as droppings, trails, or gnawing is found, abatement and control operations will begin.

Where diseases transmitted by rodents and their arthropod parasites are known to occur, rodents will be routinely monitored for the presence of the agents that cause these diseases by staff from local vector control agencies or the California Department of Health Services. If these agents are detected, appropriate rodent and ectoparasite control measures will begin. These measures will continue until the risk of human disease is over.

In all cases, vector control agencies will use control measures that are specific and minimize impact on the environment and its biota. Any disease surveillance activities associated with vertebrate vectors at the BMP sites will be done only after consultation with the Regional Supervising Public Health Biologist, California Department of Health Services, Vector-borne Disease Section.

3.4 Data Collection and Analysis

3.4.1 Data Collection

Monitoring programs will be designed to ensure that the data collected represent conditions at each BMP site.

3.4.2 Data Management

A protocol for the management, including storage, retrieval, and transfer, of data will be established before monitoring activities begin. A standardized system will be used by all agencies/contractors to collect data, and the data will be managed by an agency that is readily accessible to all participants of the study.

3.4.3 Analysis

3.4.3.1 Mosquitoes and Midges

Larvae: For each species of mosquito, the median number of larvae/dip and percent positive dips will be compared among the BMP sites and designs with nonparametric statistics, i.e., repeated measures ANOVA based on ranked abundance or Kruskal-Wallis test. If treatment is needed, post-treatment dip samples used to assess application efficacy will not be included in the analysis. Post-treatment dip samples will be defined as 24 and 48 hr post-treatment samples or weekly post-treatment sample events for which no larvae were recovered from sites treated with a residual material; i.e., samples which do not contain larvae at 2 weeks after treatment with *Bacillus sphaericus*. The number of treatments at a particular BMP site and design will be examined statistically using ranked data.

Adults: For each type of trap, the number of mosquitoes and midges collected at each BMP location will be ranked and compared across time with a nonparametric repeated-measures ANOVA. Each species and the sum of all individuals collected on each sample date will be analyzed. If an ANOVA is statistically significant ($P < 0.05$), then *a posteriori* comparisons between the medians for each BMP location will be completed to determine whether particular locations have larger mosquito populations than other BMP locations. Similar analyses will be carried out for midges.

If the data fulfill the assumptions of parametric statistical analyses, measures of central tendency and variation in abundance will be calculated for each BMP location. If abundance data have a non-normal distribution, nonparametric measures of central tendency and variation will be calculated.

The similarity of data related to gravid traps will be compared among the sites by multivariate statistical analyses using ordination. The ordinations for the background monitoring period can be compared to those for the period of BMP operation to assess whether the mosquito fauna differ temporally.

3.4.3.2 Vertebrates

Rodents trapped in monitoring studies will be counted, identified to species, sexed, measured, and weighed. These data will be used to determine:

- Species of rodents associated with BMP sites and adjacent habitat
- Approximate population densities
- Reproductive trends
- The general state of health of the local rodent population
- How monitoring results compare with earlier trapping data, and with data from other BMP locations
- Whether or not disease surveillance measures are necessary

3.4.4 Identification

3.4.4.1 Mosquitoes and Midges

Mosquitoes will be identified using the key in Bohart and Washino (1978). When the name of a species has changed since the publication of this key, the updated name will be used.

Midges will be identified to genus using Merritt and Cummins (1996). Type specimens will be sent to systematic experts for identification below the generic level.

Larval mosquitoes will be identified using the key in Bohart and Washino (1978). When the name of a species has changed since the publication of this key, the updated species names will be used. Larval midges are difficult to identify, and will be referred to experts in the taxonomy of larval midges.

3.4.4.2 Vertebrates

Rodents will be identified using *A Field Guide to the Mammals of North America, North of Mexico* (Burt and Grossenheider, 1976). When the species name has been changed since the publication of this reference, the updated name will be used.

3.5 References

Beehler, J. W. and M. S. Mulla. 1996. Larvicidal oils modify the oviposition behavior of *Culex* mosquitoes. *J. Vector Ecol*. 21: 60-65.

Bohart, R. M. and R. K. Washino. 1978. Mosquitoes of California. Univ. California Div. Agric. Sci. Publ. 4084. Berkeley.

Burt and Grossenheider, 1976. A field guide to mammals of North America, north of Mexico.

Cardarelli, N. 1976. Controlled Release Pesticide Formulations. CRC Press, Inc., Cleveland, OH.

Collins, J. N. and V. H. Resh. 1989.Guidelines for the Ecological Control of Mosquitoes in Non-tidal Wetlands of the San Francisco Bay Area. Calif. Mosque. Vector Control Assoc. and Univ. Calif. Mosquito Research Program., Sacramento, CA.

Eldridge, B. F. and B. A. Federici. 1988.Bacterial mosquito larvicides: present status of knowledge and future directions for research. Proc. Calif. Mosq. Vector Control Assoc. 56:117-127.

Kadlec, R. H. and R. L. Knight. 1996.Treatment Wetlands. CRC Press, Inc., Boca Raton, FL.

Knight, K. L. 1964. Quantitative methods for mosquito larval surveys. J. Med. Entomol. 1: 109-115.

Merritt, R. W. and K. W. Cummins. 1997. An Introduction to the Aquatic Insects of North America. Kendall/Hunt Publishing Co., Dubuque, IA.

McComas, S. 1993. Lake Smarts: The First Lake Maintenance Handbook. Terrene Institute, Washington, D.C.

Mulla, M. S. 1985. Field evaluation and efficacy of bacterialagents and their formulations against mosquito larvae. pp. 227-250.*In*: M. Laird and J. W. Miles (eds.), Integrated mosquito control methodologies. Vol. 2. Academic Press. London.

O'Malley, C. 1995. Seven ways to a successful dipping career. Wing Beats 6(4): 23-24.

Reiter, P. 1983. A portable, battery-powered trap for collecting Culex mosquitoes. Mosq. News 43: 496-498.

Reiter, P. 1987. A revised version of the CDC gravid mosquito trap. J. Am. Mosq. Control Assoc. 3: 325-327.

Siegel, J. P. and R. J. Novak. 1997.Field trials of VectoLex CG, a *Bacillus sphaericus* larvicide, in Illinois waste tires and catch basins. J. Am. Mosq. Control Assoc. 13: 305-310.

Service, M. W. 1980. A Guide to Medical Entomology. MacMillan International College Editions. London.

Service, M. W. 1993. Mosquito Ecology - Field Sampling Methods. Chapman and Hall. London.

4.0 HEALTH AND SAFETY

This section focuses on promoting and maintaining safe work practices through the use of written procedures to identify and control potential physical and/or environmental hazardous conditions at the various BMP Retrofit sites.

The purpose of the section is to heighten awareness of the maintenance and monitoring personnel's understanding of the potential physical and/or environmentally hazardous conditions that may occur during the execution of the tasks and procedures associated with operation and maintenance of the BMP retrofit pilot program. Traffic and worker safety for maintenance and monitoring activities will be reviewed, as well as equipment operations for the identification and control of hazardous conditions to help reduce injuries in the field.

A hazard is any existing or potential condition in the field which, by itself or by interacting with other variables, can result in the unwanted effects of injuries, property damage, and other losses.

This definition carries with it two significant points:

- A hazardous condition does not have to exist at all times to be classified as a hazard when the situation is being evaluated.

- A hazardous condition may not result from independent failure of workplace components but from one BMP site component acting upon or influencing another.

In any maintenance and monitoring activity, personnel, equipment, and materials interact within the BMP site environment to assess the maintenance requirements and collect field samples. By consciously reviewing traffic and worker safety policies and procedures personnel can successfully conduct the maintenance and monitoring activities in the safest possible manner. The Caltrans publication *Code of Safe Operating Practices, July 1991,* details the general operating procedures applicable during all maintenance activities which shall be followed while performing all maintenance and monitoring duties.

Consultants are required to prepare health and safety plans consistent with the consultant's general organizational health and safety plan and, at a minimum, should include emergency procedures and contact information. Special attention should be paid to Traffic and Worker Safety. Guidelines on preparing these sections are given below.

4.1 Traffic Safety

Traffic safety for maintenance and monitoring at the BMP sites shall comply with Chapter 8 "Protection of Workers" [revised June 1999] of the *State of California Department of Transportation, Maintenance Manual, Volume 1, (June 1998).* See Appendix D-2.

4.2 Worker Safety

Worker and equipment safety for maintenance and monitoring at the BMP sites shall comply with the *Caltrans Code of Safe Operating Practices,* July 1991 and Chapter "Protection of Workers" *(revised June 1999)* of the *State of California Department of Transportation, Maintenance Manual, Volume 1, (June 1998).* The relevant chapters from each of these publications are located in Appendix D-1 and D-2, respectively.

4.2.1 Safety Issues During Maintenance Inspections

Safety issues during maintenance inspections are, for the most part, common sense and good judgement, which should be considered while within Caltrans right-of-way. Possible concerns or issues include:

- Be aware of transients. They are territorial. If transients are present at the maintenance site contact the CHP at 911 and the Caltrans Maintenance Manager. (See Appendix D-3.)

- Look out for holes. A hole can be very small in circumference but deep. In the vicinity of a stormwater management facility a hole can be an indication of a serious problem. Document the location and physical characteristics of the hole. While monitoring and/or performing a survey, ***look where you walk.***

- Animals can present a serious concern. Rabies and Hantavirus is a concern with wildlife and animal bites, which could have severe consequences. Be careful around geese. Geese are very territorial, and can be extremely aggressive. Look out for snakes.

- Do not attempt to handle materials found on the roadside, notify Caltrans or the CHP if they are a hazard. Contact the Maintenance Manager and Area Superintendent (See Appendix D-3). Specific items that should never be handled include:

    - Materials you suspect may be toxic or hazardous
    - Chemical drums or containers
    - Weapons or suspicious packages
    - Syringes hypodermic needles or broken glass
    - Dead animals (Hantavirus)

- Be careful lifting manhole covers or other structural covers that may be located within the area of the proposed stormwater facilities. These items can be very heavy, can slip, and cause serious injury, such as the loss of a finger. In addition, since they are heavy, back problems can occur if covers are lifted alone or incorrectly.

- Poison ivy, poison oak, or other plants can present a problem depending on the individual's allergic reaction to them. This can also present a problem during maintenance when vines from cutting woody vegetation may lie all over a site. Know what these plants look like and avoid them in the field.

- Never enter a confined space unless you have been trained and have proper safety equipment in accordance with OSHA Regulations. Do not enter pipes or conduits unless another individual is present during the inspection. Do not enter a pipe or conduit, even with others present, if there is any concern regarding the structural strength of the pipe or conduit.

- Never enter a manhole or other drainage facility, which is conveying or detaining water unless you have been trained and have proper safety equipment in accordance with OSHA Regulations.

- Be careful not to walk in water when the depth is unknown, algae and/or scum are present, a current is present, or where there may be steep slopes below the water line.

- Be careful of nails, broken glass, or other sharp objects. Soft bottom shoes, such as athletic shoes, may be more comfortable for general wear, but they are not as safe as hard soled shoes. Fences can tear clothing or cause cuts, which may necessitate medical treatment. Steel-toed work boots are required at all times when inspections are being performed.

- Wear gloves if you are going to handle any mechanical parts or structural components. For health and safety reasons, wear gloves appropriate to the material the being handled, especially where pollutants or other materials can coat the hands then get rubbed into eyes or the mouth. Always wash your hands after an inspection where items are manipulated, especially if gloves are not worn.

- In systems that are somewhat sealed and are poorly ventilated, be careful with cigarettes, lighters, or other open flames. Smoking is not allowed at any time during site inspections. Also be sure to allow a facility to vent for a period of time if a peculiar odor is present. Do not enter any confined space unless the atmosphere has been checked and proper safety equipment is worn and/or erected. Never enter a confined space unless you have been trained and have proper safety equipment in accordance with OSHA Regulations.

- Hard hats shall be worn during all monitoring and/or inspection surveys.

- For daytime work, a vest, shirt or jacket shall be orange, yellow, strong yellow green or fluorescent versions of these colors shall be worn during all monitoring and/or inspection surveys. For nighttime work, similar outside garments shall be retro-reflective.

4.2.2 Safety Issues During Maintenance and Monitoring Activities

Protect yourself during maintenance and monitoring activities, which requires working with, or in close proximity to, any equipment operation. Some general rules to keep in mind are:

- At sites where equipment operation is occurring, assume the operator will not see you – it is **YOUR RESPONSIBILITY** to be sure that you stay out of the way and when necessary, to be sure the operator **HAS** seen you **BEFORE** you proceed.

- Two-person field crews shall be assigned for all maintenance and monitoring activities.

- Assess site conditions for safety and review procedures prior to engaging in any activities at the site.

- Equipment should always be operated safely and in accordance with manufacturer's specifications.

- Contact Underground Service Alert (USA) at 1-800 442-4133, 48 hrs before initiating any maintenance activity involving any excavation. Look for overhead wires before operating any equipment, which could touch the wires.

- Before starting any maintenance activity, be sure that all necessary equipment or replacement parts are onsite or are readily available. In the case of sediment removal, have the disposal location staked out or identified.

- Excavated areas that cannot be filled at the end of a workday should be covered, when possible, or clearly identified and marked off.

- When you are working in a residential community, inform the residents of the nature of the maintenance activity and how long it will take.

- Don't cut corners when doing maintenance activities. Be careful. Always be aware of what is around you. Take the time needed to do the job right. Recognize that things go wrong, and taking time to do quality work will save time and money in the long run.

- Wear a hard hat, safety vests, steel-toed shoes, safety glasses, ear plugs, etc. if in an area where construction equipment (or operating equipment) is operating.

- Mowing can be hazardous so be careful around mowers that are running. Take special care when mowing steep slopes. Be sure to wear safety glasses, steel-toed shoes, and earplugs while mowing.

- Wear gloves when handling any mechanical parts or structural components.. As stated before, this needs to be done for both safety and health reasons. Always wash your hands after an inspection where items are manipulated, especially if gloves are not worn.

5.0 SAMPLING AND ANALYSIS

Each BMP used in the retrofit pilot program will be monitored to determine its characteristics and function, constituent removal effectiveness, and suitability of operation and maintenance procedures. Parameters important to BMP performance and effectiveness will be recorded.

Each design is intended to remove specific constituents present in highway runoff; consequently, the type of analyses performed will depend on the runoff control or BMP under consideration. Water quality samples from runoff controls that are designed to remove a wide range of constituents will be analyzed for solids, heavy metals, nutrients and total petroleum hydrocarbons (TPH).[1] The samples from other, more specialized controls will be analyzed for the appropriate subset of these constituents.

Documentation will include field observations of the installations before, during and after storm events. Field observations will be related back to specific design details for a specific site, noting characteristics that are either beneficial or detrimental to the performance of the device.

5.1 Project Parameters

BMPs will be monitored to meet the requirements of the District 7 Scoping Study. Stormwater samples for the appropriate BMPs will be collected to conduct post-construction water quality studies. Stormwater samples will be collected from up to four storms per year, weather permitting, with a maximum of eight storms over a 2-year period for most BMPs. The exception to this is that only four storms will be monitored for the extended detention basin.

5.1.1 Defining a Successfully Monitored Event

For events in the 99/00 wet season and beyond, twelve aliquots, 75% capture and 0.1 in. of rain will serve as general criteria for defining a successfully monitored event. Monitoring teams will only send samples for analysis when the criteria are met for both influent and effluent.

5.1.2. Criteria for Mobilization

A 50% or greater probability of 0.25 in. of rain is required at a minimum for monitoring crew to mobilize. Probabilities of 0.25 in. of rain at 50% greater than but less than 75% require that Calrans decide whether or not to mobilize. Mobilization will occur if the 0.25-in. storm is predicted with 75% or greater probability.

[1] Total petroleum hydrocarbons will be analyzed for gasoline, diesel and oil for each of the BMPs whenever hydrocarbons are mentioned in this document.

5.2 Constituent Selection and Analytical Method

5.2.1 Constituents

The Scoping Study for District 7 (CTSWRT-98-027) specifies the constituents that will be sampled for this study. A list of constituents to be monitored in stormwater runoff is provided in Table 5.1. This list applies to all BMP types in this study, with the exception of:

- *Infiltration Trenches and Basins:* Only lead, copper and zinc will be analyzed for this BMP in the influent vadose zone. Groundwater quality changes relatively slowly in response to changes in the characteristics of the recharged water, so an intensive monitoring program is not necessary. Based on previous water quality monitoring of runoff from highways in the Los Angeles area, the main dissolved constituents of concern are heavy metals. For infiltration basins, TSS will not be measured but all other constituents will.

- *Oil Water Separators:* Only conventional analytes and total petroleum hydrocarbons (TPH) such as diesel, gasoline and oil, and oil and grease will be analyzed for this BMP.

Appendix E-1 provides a matrix that specifies the particular constituents to be monitored for each BMP type. A description of the location to be sampled (e.g., inlet, outlet, etc.) and media (groundwater, sediment, etc.) are also included.

5.2.2 Analytical Methods

Since these constituents may impair beneficial uses of receiving waters at extremely low concentrations, it is important that analytical methods be selected which have appropriate detection limits. In addition, many of the water quality samples will be collected after treatment by a BMP and will have concentrations below what is normally found in untreated highway runoff. The analytical methods recommended in Table 5-1, should provide accurate results at concentrations that might be expected in the discharge from retrofit BMPs.

5.2.3 Sediment Characterization

Sediment collected within certain BMPs must be characterized annually at the end of the monitoring period and analyzed to determine if disposal is needed. This applies to media filters, biofiltration strips and swales, multichamber treatment trains, extended detention basins and the wet
basin.

Table 5.1 Stormwater Matrix
Analytical Parameters, Methodologies, Reporting Limits, Holding Times, Container Volumes and Types, and Preservation

Analyte	Priority Rank	Reporting Limits	Units	Analytical Technique	Method Number	Holding Time	Preferred Sample Volume and Container Type[1]	Preservation
Conventionals								
pH	1	0.1	Unit	Electrode	EPA 150.1	Immediately[2]	1-100 mL glass/plastic	4°C
Specific conductance	1	1.0	:mhos/com	Electrometric	EPA 120.1	Immediately[2]	1-6500 mL glass/plastic	4°C
Hardness	5	2	mg/L	Titrimet-ric/clorimetric	EPA 130.2	6 mos	1-250 mL glass/oplastic	4°C
TSS	1	1	mg/L	Dried filter weight	EPA 160.2	7 days[3]	1-100 mL glass/plastic	4°C
Nutrients								
Nitrate-nitrogen	2	0.01	mg/L	Colorimetric/Ion chromatography	EPA 353.3	28 days	1-500 mL glass	4°C and H_2SO_4 to pH<2
Total Kjedahl nitrogen[1]	3	0.1	mg/L	Titrimet-ric/colorimetric	EPA 351.3	28 days	1-1L glass	4°C and H_2SO_4 to pH<2
Total phosophorous	4	0.002	mg/L	Colorimetric	EPA 365.3	28 days	1-100 mL glass	4°C and H_2SO_4 to pH<2
Total and Dissolved Metals [4,5]								
Copper	1	1	:g/L	ICP-MS	EPA 200.8	6 mos	1-100 mL plastic	4°C and HN)3 to pH<2 and filter
Lead	1	1	:g/L	ICP-MS	EPA 200.8	6 mos	1-100 mL plastic	4°C and HN)3 to pH<2 and filter
Zinc	1	1	:g/L	ICP-MS	EPA 200.8	6 mos	1-100 ml plastic	4°C and HN)3 to pH<2 and filter
Organics								
Total Petroleum Hy-drocarbons as diesel and gasoline	Grab	0.25-0.75	mg/L	GC-MS	EPA 8015M	7 days	2-1L amber glass	4°C and H_2SO_4 to pH<2
Bacteria								
Fecal coliform	Grab	2	MPN/ 100 mL	Plate count	SM 9221E	6 hr	1-100 mL plastic	4°C

[1]Analysis with the same preservative can be combined into a single container if the same laboratory is performing the analyses. Samples volumes to be determined by laboratory.
[2]pH and specific conductance will be measured by the laboratory immediately upon receipt of the samples.
[3]7 days based upon limit for measuring TSS/no reguatort luimiut.
[4]Total and dissolved metals samples are collected in separate containers.
[5]Dissolved metals will be filtered in the labaoratory prior to acidification.

5.3 Sampling Methods and Equipment

5.3.1 Sample Collection Methods

Stormwater samples can be collected to represent a point in time (i.e., "grab" sample) or a period of time (i.e., "composite" sample). A grab sample is essentially a one-time collection of a sample volume adequate to perform the intended water quality analysis. A composite sample is comprised of some number of individual sample aliquots mixed together. For stormwater monitoring, this usually refers to samples collected sequentially over time during a stormwater runoff event.

Stormwater samples can be collected using either manual or automated means. In most cases, automated composite sampling is the recommended sample collection method; however, manual grab sampling is required for certain constituents.

Grab samples are required for monitoring parameters that transform rapidly, require special preservation, or adhere to bottles. For example, samples to be analyzed for TPH and bacteria must be collected as grab samples only. Grab samples are required for selected storms for extended detention basins, biofilters, media filters and the wet basin. It is anticipated that two of the four required storms will be sampled by grab method. The pH will be measured at the time of sampling. The only types of BMPs for which grab sampling is not required are the infiltration devices (infiltration trench and infiltration basin).

Samples for bacteriological analysis will be collected in sterile bottles. Sterile Teflon bailers are available for this purpose; otherwise, the sample must be collected directly into the sterile "bacti" bottle. Clean techniques must be used when collecting bacteriological samples. Sampling methods at each BMP type are required and are described below.

Extended Detention Basins: Automatic sampling equipment will be installed at the inlet and outlet of the device to collect flow weighted composite samples.

Infiltration Basins: The sampling method will depend on the depth to groundwater at the site. If the groundwater level is within about 10 m (33 ft) of the basin floor, a monitoring well will be constructed to allow water quality samples to be collected twice a year from the saturated zone. The well will be installed adjacent to the basin to prevent possible short-circuiting down the annulus of the well and to facilitate access and sampling. Baseline sampling of groundwater will be completed prior to operation of the device.

If the normal groundwater level is deep (greater than 10 m), or other geologic conditions such as an aquitard are present, then samples will be collected from the vadose zone. This type of sampling requires a pressure-vacuum lysimeter. The lysimeter will be installed according to the manufacturer's recommendations and placed so that samples are collected at a depth of 1-2 m (3-6 ft) below the basin floor. This type of sampling is only appropriate for the analysis of dissolved constituents, because the water must be drawn through a ceramic or Teflon cup.

Core samples in the infiltration basin will be collected to determine the rate at which constituents are transported into the subsurface. Samples of soil will be collected from depths of 0.3 m and 0.6 m (1 ft and 2 ft) in the infiltration basin and analyzed for zinc, lead, copper, and total petroleum hydrocarbons. Similar samples will also be collected and analyzed immediately following completion of construction for comparison. There will be no sampling of the influent to the infiltration basin.

Infiltration Trench: Water quality samples will be collected from the vadose zone below the trenches since the water table is at least 10 m below the bottom of the trench at each of the pilot project sites. This type of sampling requires a pressure-vacuum lysimeter. The lysimeter will be installed according to the manufacturer's recommendations and placed so that samples are collected at a depth of 1-2 m (3-6 ft) below the trench floor. This type of sampling is only appropriate for the analysis of dissolved constituents, because the water must be drawn through a ceramic or Teflon cup.

Biofiltration Swales and Strips: Flow-weighted composite samples will be collected for influent and effluent for the vegetative controls to check for most constituents. Manual grab samples will be collected during selected events to determine the instantaneous concentrations of total petroleum hydrocarbons, and fecal coliform.

Media Filters: The runoff samples collected by the automatic sampling equipment will be analyzed for most chemical constituents for influent and effluent. Manual grab samples will also be collected during selected storm events to determine the instantaneous concentrations in the treated and untreated runoff for total petroleum hydrocarbons, and fecal coliform. At the end of the monitoring period, samples of the sediment which has been retained by the filter will be collected and analyzed to determine the proper disposal method.

Continuous Deflective Separation (CDS) Units: Influent and effluent flow-weighted composite sampling will be used to sample for most constituents listed in Table 5.1. For the effluent, the sampler intake will be located between the CDS and downstream litter collection bag. Influent and effluent grab samples will also be collected to analyze for organics and fecal coliform. Material collected within the CDS will be collected and characterized annually to determine the proper disposal method (at the end of the wet season), or when material is at 85% of CDS's capacity, whichever occurs first. Monthly, or prior to a target storm, the amount of litter and debris collected in the CDS will be reported. Material collected in the litterbag downstream of the CDS will be monitored for its volume and mass, four storms per wet season, and annually at the end of the wet season, or when the litter collection bag is full.

Drain Inlet Inserts*:* Composite samples will be collected from the catchment discharge and analyzed for the parameters shown in Table 5.1. The constituent removal efficiency of the inserts will be determined by extracting the sediment, nutrients, metals, and hydrocarbons from the inserts. Knowledge of the effluent quality and quantity will allow calculation of the influent quality by performing a mass balance on the catch basin inserts.

Oil Water Separators: Grab samples are required for analysis of oil and grease concentrations, with efficiency based on a comparison of paired samples.

Multi-Chambered Treatment Train (MCTT): Automatic sampling equipment will be installed at the inlet and outlet of the device to collect flow weighted composite samples. The samples will be analyzed for the suite of analytical constituents.

5.3.2 Flow Measurement Equipment

Sites, which require the collection of flow, weighted composite samples and rainfall data will be equipped with automatic samplers, data loggers, flow meters and rain gauge. The equipment will be selected, installed and maintained according to the *Caltrans Guidance Manual: Stormwater Monitoring Protocols* (LWA, 1997)**.**

Flow measurements are required for accurate sample compositing and are described below for each of the retrofit sites.

Extended Detention Basins: The most appropriate flow measurement structures for basin inlets are Parshall flumes and H flumes. An advantage of these devices is their ability to pass trash and other debris, which tend to accumulate in structures such as V-notch weirs. The high velocity through the flume prevents sediment accumulation from runoff with high suspended solids concentrations. In addition, these devices operate with a much smaller head loss than a weir. Depending on the size of the contributing watershed, an H flume is preferred because of its ability to accurately measure a wider range of flows.

Flow measurement at the basin outlet is subject to different constraints than at the inlet. Because of the long detention times, flow rates will necessarily be much lower and most of the trash and debris will have been removed from the runoff. Therefore, a V-notch weir is the preferred option for measuring flow at this location. The type and size will be determined by the size of the watershed and expected discharge rate from the basin.

Infiltration Basin: The rate of stormwater infiltration will be measured by installing an automated flow meter in the basin. The meter will be a bubbler type device. The meter will record changes in water depth in the basin so that the infiltration rate can be calculated. The data will also indicate how the infiltration rate changes over the course of the study period and indicate when maintenance is required to remove material that has accumulated on the surface of the basin.

Infiltration Trenches: A monitoring well will be constructed in each of the infiltration trenches to monitor the rate of infiltration into the soil and to determine whether the trenches are draining in the recommended time. Measurements of water level in the monitoring well will be made twice a year following rainfall events of at least 12 mm (0.5 in.). This data will indicate the rate of infiltration under typical conditions and assess how that rate changes during the monitoring period.

Biofiltration Swales and Strips*:* At a Swale/Strip, both primary and secondary flow metering devices will be used. A primary flow measuring device is a hydraulic structure inserted into a channel that monitors changes in liquid level in or near the structure. By knowing the shape and

dimensions of the hydraulic structure, flow through or over the structure is related to the liquid level by a mathematical relationship. A secondary flow metering device measures both liquid depth and/or velocity. Primary devices are preferable, unless hydraulic characteristics prohibit them. A primary flow measuring discharge flume will be used at each sampling point. A bubbler will be used in conjunction with the flume. The bubbler measures the hydrostatic pressure of the liquid. The bubbler tube will be connected to the flume's stainless steel bubbler tube.

Media Filters: The most appropriate flow measurement structures for filter inlet are Parshall flumes and H flumes. An advantage of these devices is their ability to pass trash and other debris, which tend to accumulate in structures such as V-notch weirs. The high velocity through the flume prevents sediment accumulation from runoff with high suspended solids concentrations. In addition, these devices operate with a much smaller head loss than a weir. Depending on the size of the contributing watershed, an H flume is preferred because of its ability to accurately measure a wider range of flows.

Flow measurement at the filter outlet is subject to different constraints than at the inlet. Because of the long detention times, flow rates will necessarily be much lower and most of the trash and debris will have been removed from the runoff. Therefore, a V-notch weir is the preferred option for measuring flow at this location. The type and size will be determined by the size of the watershed and expected discharge rate from the filter.

Continuous Deflective Separation (CDS) Units: The sampler will be triggered by flow entering the H-flume located downstream of the CDS. The rate of stormwater infiltration will be measured by installing an automated flow meter in the basin. The meter will be a bubbler type device.

Drain Inlet Inserts: Rainfall will be measured at another fully instrumented site in the vicinity. The sites selected for installation of these devices will be nearly 100% paved so the total rainfall can be easily used to calculate the total volume of runoff treated.

Oil/Water Separators*:* A flow-measuring discharge flume will be used at the discharge sampling point. A bubbler flow meter (or equivalent) will be used in conjunction with the discharge flume.

Multi-Chambered Treatment Train (MCTT): These sites will be designed to incorporate flow measurement structures. The most appropriate flow measurement structures for the MCTT inlet are Parshall flumes and H flumes. An advantage of these devices is their ability to pass trash and other debris, which tend to accumulate in structures such as V-notch weirs. The high velocity through the flume prevents sediment accumulation from runoff with high suspended solids concentrations. In addition, these devices operate with a much smaller head loss than a weir. Depending on the size of the contributing watershed, an H flume is preferred because of its ability to accurately measure a wider range of flows.

Flow measurement at the basin outlet is subject to different constraints than at the inlet. Average flow rates will necessarily be lower because of the media filtration chamber and most of the trash and debris will have been removed from the runoff. However, during large storms, runoff will

bypass the filter chamber and discharge rates will be equal to the influent rate. Therefore, a compound V-notch weir is the preferred option for measuring flow at this location. The type and size will be determined by the size of the watershed and expected discharge rate from the MCTT. Flow weighted composite samples will be collected at both the inlet and outlet of the MCCT. The samples will be analyzed for the suite of analytical constituents.

5.3.3 Data Management

Efficient data storage, retrieval, and transfer methods will be established prior to initiation of monitoring activities. LWA (1997) provide a number of suggestions for the development of a data management system. In addition, the technical memorandum, "Caltrans Data Management Plan–Data Reporting Protocol and Database," Doc. I.D. CTSW-TM-98-005, provides details of Caltrans data management program (see Appendix E-3 for this memo).

5.3.4 Bottle and Equipment Cleaning

Prior to each stormwater monitoring event, sample bottles and sampling equipment will be cleaned and installed as specified by the *Caltrans Guidance Manual: Stormwater Monitoring Protocols* (LWA, 1997).

All Teflon tubing will be replaced at the beginning of each wet season with new teflon tubing that has undergone the correct decontamination procedures specified below.

1. Teflon hose will be rinsed three times with a 2% Micro solution or equivalent. Other sampling equipment will be:
2. Washed with a 2% Micro solution and a clean plastic brush
3. Rinsed three times with warm tap water
4. Rinsed three times with Milli-Q or equivalent water
5. Rinsed three times with 2N nitric acid
6. Soaked at least 24-hours in 2N nitric acid
7. Rinsed three times with Milli-Q water

5.4 Training

5.4.1 Review Sampling Plan and Health and Safety Plan

All stormwater sampling team members and alternates should read the entire stormwater monitoring plan, to obtain both the background information required for an overall understanding of the goals of the Caltrans monitoring program, and specific information related to the accomplishment of individual tasks. Team members should also read the health and safety plan, to become aware of the potential hazards associated with stormwater sampling, and become familiar with the methods to be employed to cope with those hazards.

5.4.2 Classroom Training Session

A classroom-format training session will be held for all stormwater sampling team members and alternates, to review the sampling techniques and protocols specified in the monitoring plan. Ideally, the training session would occur shortly before the expected onset of the wet season.

The following documentation should be reviewed thoroughly by training personnel during the preparation of a training session outline:

- Sampling plan and standard operating procedures
- Health and safety plan
- Monitoring equipment manuals
- EPA sampling protocols

The training session will be organized in a chronological fashion, in order to follow the normal train of events from pre-monitoring preparations through post-monitoring activities. All standard operating procedures for the sampling equipment will be covered, along with the site-specific responsibilities of individual team members. In addition, any questions arising from the document review should be addressed during this session. An example of a basic classroom stormwater training session outline is shown in Figure 5.1.

Training personnel will circulate a copy of the sampling plan, health and safety plan, and all other appropriate documentation during the training session. The following is an example of items that will be on hand during a training session:

- Documentation (sampling plan, site-specific operating procedures, health and safety plan, example of weather forecast, etc.)
- An example chain-of-custody form
- Storm kit and sampling supplies
- Portable monitoring equipment and water (for demonstration purposes)
- Sample bottles and example bottle labels

Key sections of the sampling plan will be highlighted during the training session, and use of all equipment should be demonstrated. In order to emphasize the importance of minimizing sample contamination, special attention should be given to proper sample handling techniques. Ample opportunity will be provided to answer questions posed by field crew members.

Figure 5.1
Classroom Stormwater Training Session Outline

1.0 Present an overview of the project
- 1.1 Driving force of the project
- 1.2 Project goals
- 1.3 Project duration
- 1.4 Sampling site locations

2.0 Responsibilities of everyone involved with the project

3.0 Weather tracking/storm selection

4.0 Station preparation and maintenance
- 4.1 Pre-storm site visits
- 4.2 Storm event site visits

5.0 Sample bottle ordering, labeling and preparation

6.0 Notification procedures
- 6.1 Storm action levels
- 6.2 Telephone tree

7.0 Sample collection
- 7.1 Sampling site safety
- 7.2 Traffic Control
- 7.3 Clean sample handling protocols
- 7.4 Flow measurement and equipment
- 7.5 Sampling equipment operation
- 7.6 Grab and composite sample collection procedures
- 7.7 QA/QC sample collection
- 7.8 Sample preservation
- 7.9 Sample delivery

8.0 Demobilization of field crews
- 8.1 Demobilization decision
- 8.2 Station shut down
- 8.3 Sample delivery
- 8.4 Chain of custody

9.0 Open discussion/questions and answers

5.4.3 Field Training/Sampling Simulation

After classroom training, all sampling team members and alternates will attend a field training sampling simulation, or "dry run," under the supervision of the project manager or sampling team leader. The "dry run" should begin with a brief review of the classroom session. During the "dry run," sampling team members travel to their assigned sampling locations and go through the procedures specified in the Sample Collection section of the sampling plan, including:

- Site access and parking at the site
- Traffic control measures (if any)
- Calibrating field equipment
- Preparing the stations for monitoring
- Taking field measurements
- Collecting stormwater samples
- Downloading data from automated equipment
- Completing sample labels and field log forms
- Packing samples
- Delivering or shipping samples to the laboratory

All of the equipment and materials required for a wet sampling event will be mobilized and used to simulate, as closely as possible, the conditions of an actual sampling event. All stormwater monitoring team members (including alternates) will receive hands-on training with all field equipment and sample handling procedures. The project manager or sampling team leader will re-emphasize health and safety considerations during the field sampling simulation.

5.5 Preparation and Logistics

Adequate pre-storm preparations are essential for a successful stormwater monitoring event. Prior to deployment of field crews and the initiation of stormwater monitoring, it is imperative that weather systems are adequately tracked, field personnel are prepared, all necessary equipment is inventoried, and sample bottles are labeled. Stormwater monitoring preparation and logistics should include the following basic elements.

5.5.1 Weather Tracking

A crucial role of weather forecasting is projection of a quantity of precipitation forecast for an impending storm. This is the amount of precipitation expected for the storm event, and is normally provided along with the expected duration of the storm. This information serves two essential purposes. First, it is necessary to determine, prior to making the decision to mobilize for a storm event, whether the storm will produce adequate runoff to permit collection of a meaningful set of samples. Second, because composite samples are typically collected on a flow-weighted basis, the sampling equipment must be programmed to collect samples at appropriate intervals so as to not under-fill nor over-fill the composite bottles, based on the rainfall/runoff amounts expected during the course of the storm.

During the wet season, when the stormwater monitoring program is active, the monitoring task manager or field coordinator continuously tracks weather conditions and potential storms. The

frequency of weather tracking increases as incoming storms are identified as candidates for stormwater monitoring.

Sources of weather information to be used to track incoming storms are as follows:

Source	Internet Address or Telephone Number
National Weather Service web page	www.nws.fsu.edu http://nimbo.wrh.noaa.gov/ Oxnard
Weather Watch Service	(619) 223-8163
Continental Weather and Earth Sciences, Inc.	1-800-THE RAIN
Alert system from Los Angeles County	http://www.nwsla.noaa.gov
The Weather Channel and local news stations	Cable TV; broadcast TV
Radar and satellite images downloaded from Internet sources	The Weather Channel - www.weather.com The Weather Underground - www.wunderground.com Weather - www.intellicast.com

5.5.2 Storm Action Levels

It is recommended that storm action levels be defined for the purpose of stormwater monitoring preparation, mobilization, and demobilization. An example of storm action levels is shown in Figure 5.2. All project management, field personnel, and laboratory personnel involved are notified each time there is a storm action level change.

5.5.3 Communications

A telephone tree will be developed, and included in Volume 2, to clearly define lines of communication and notification responsibilities. The telephone tree is used for stormwater monitoring preparation activities, personnel notification of storm action level changes, communications during stormwater monitoring, and coordinating demobilization activities following a monitored storm event. An example of a telephone tree is presented in Figure 5.3.

5.5.4 Ordering Sampling Bottles

Prior to the first targeted storm of each monitoring season, and immediately following each monitored event, a sample bottle order is placed with the analytical laboratory. Bottles are ordered for all planned stormwater samples, including quality control samples. The bottles must be the proper size and material, and contain preservatives as appropriate for the specified laboratory analytical methods. Composite bottles must be pre-cleaned according to the procedures specified in *Caltrans Guidance Manual: Stormwater Monitoring Protocols* (LWA, 1997). Field crews must inventory sample bottles upon receipt from the laboratory to assure that adequate bottles have been provided to account for the analytical requirements of all composite and grab samples.

Figure 5.2 Storm Action Levels for BMP Facilities with Large Drainages

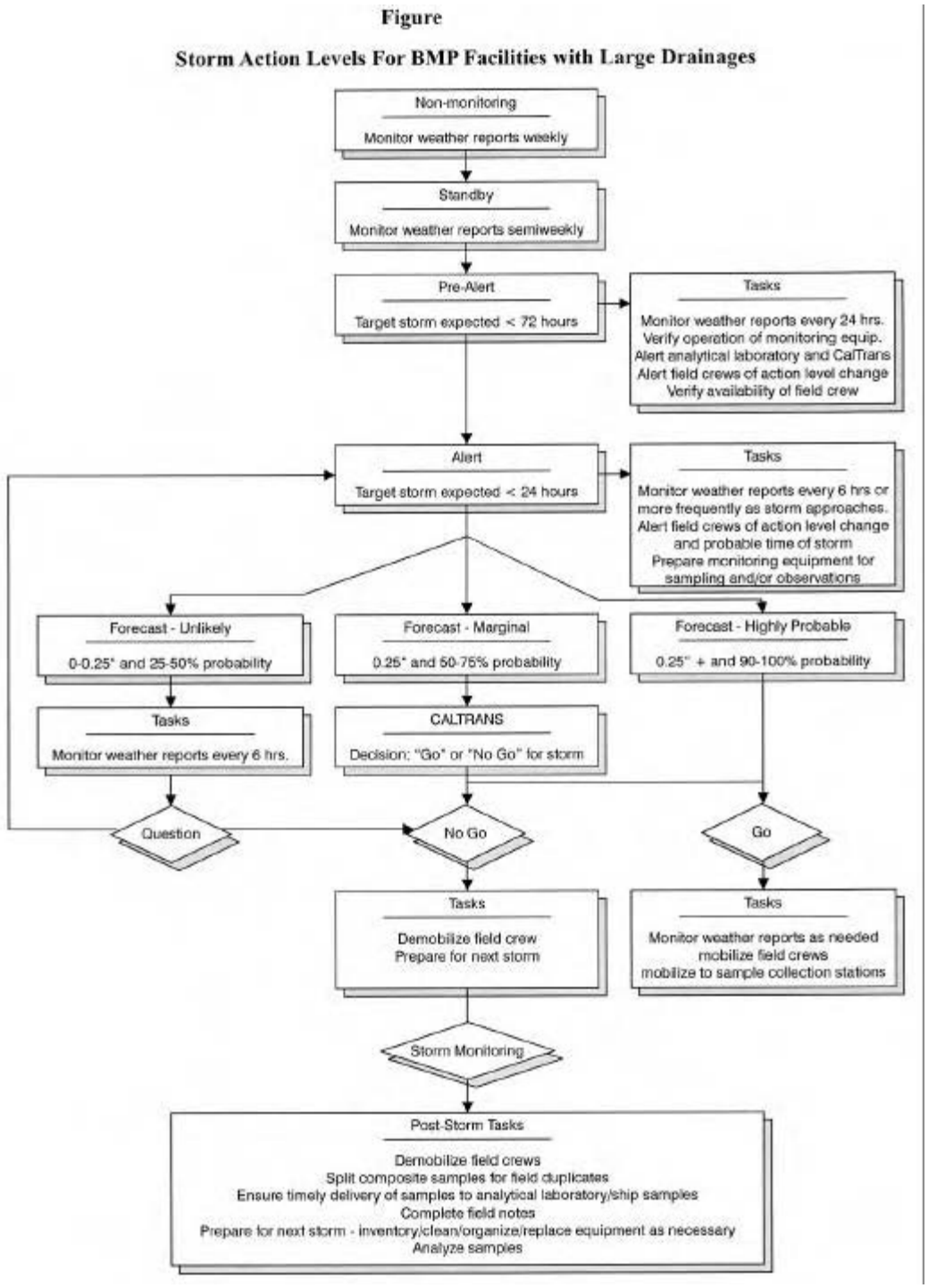
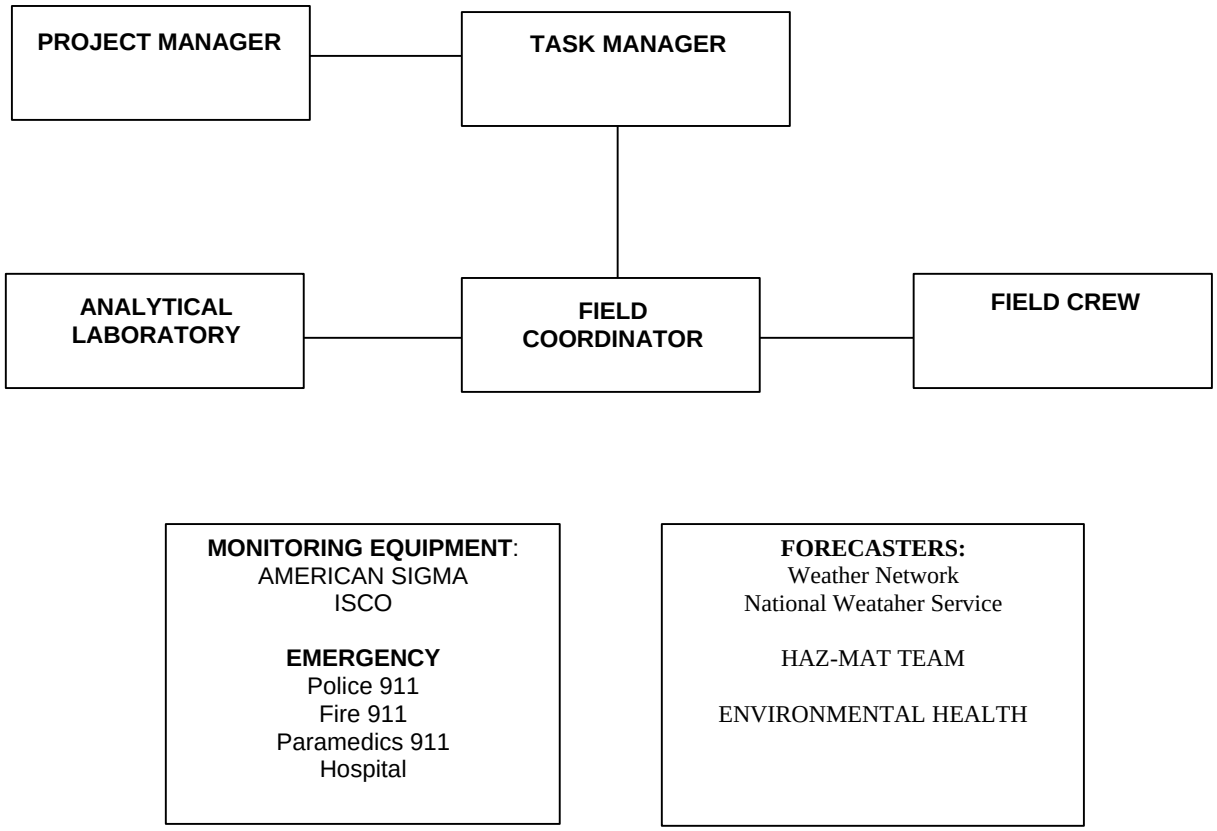


Figure 5.3

Telephone Tree Example



5.5.5 Sample Bottle Labeling

All sample bottles will be pre-labeled before each stormwater monitoring event. Pre-labeling sample bottles simplifies field activities, leaving only date, time, sample number, and sampling personnel names to be filled out in the field. Basic water-proof bottle labels are available pre-printed with space to pre-label by hand writing or typing. Custom bottle labels may be produced using blank water-proof labels and labeling software. A standardized bottle label should include the following information, with other items as appropriate:

- Project Name
- Station Name
- Event Number
- Date and Time
- Sample Type
- Sample __ of __
- Collected by:
- Preservative
- Analysis, and
- Sampler's Initials

5.5.6 Field Equipment Preparation

Prior to the first targeted storm event of each monitoring season, and immediately after each monitored event, the field crews will inventory, restock, replace, clean, calibrate, maintain, and test field equipment as needed. Field equipment is inventoried using a comprehensive checklist of all required field equipment (tools, sample bottles, flashlights, extra batteries, safety equipment, first-aid kit, cellular telephone, etc.). Field equipment should be kept in one location which is used as a staging area to simplify field crew mobilization. An example field equipment checklist is provided as Figure 5.4.

The following equipment preparation procedures will be conducted prior to each targeted storm:

- Inspect the pump tubing and replace if necessary
- Inspect intake tubing condition and connections
- Inspect desiccant cartridges in sampler and flow meter
- Check all electrical connections
- Ensure that batteries are adequately charged and positioned
- Insert sample bottles into sampler (check for proper bottle position)
- Reset automatic sampler
- Calibrate any portable analytical meters that will be used to make field measurements

At a minimum, the frequency and nature of equipment maintenance for all field equipment should be consistent with the manufacturer's recommendations.

Figure 5.4
Field Equipment Checklist

Storm Kit Equipment List		Storm Mobilization Equipment List	
?	First aid kit	?	Storm kit
?	Keys (to gates and to enclosures)	?	Log books/log sheets
?	Flashlights (2) - hand held and head mounted	?	Paper towels
?	Maps	?	D.I. water squirt bottles
?	Large flat screwdriver	?	Ice scoop
?	Small flat screwdriver	?	Chain of custody forms
?	Umbrella - large size	?	Appropriate number of composite bottles with mesh carriers and buckets
?	Alkaline D-cell batteries for flashlights	?	Appropriate number of grab sample bottles
?	Spare alkaline D-cell batteries for flashlights	?	Bottle labels
?	"Write in the rain" pens (2) (waterproof, fine-point markers)	?	Coolers and ice
?	Spare sample bottle labels	?	Grab pole, rope and duct tape
?	Desiccant (for samplers and flow meters)	?	D.I. water
?	Diagonal cutters	?	Laboratory-provided blank water
?	Electrical tape	?	Cellular phone
?	Cable ties (assorted sizes)	?	Personal extra change of clothes
?	Utility knife	?	Lighting
?	Ziplock baggies (assorted sizes)	?	Personal rain gear
?	Gloves – powder free nitrile	?	Hard hats and orange safety vests
?	Duct tape	?	Traffic cones/signs
?	Rubber bands	?	SOPs/Health and Safety Plan

5.5.7 Mobilization of Field Crews

When a candidate storm is approaching (i.e., the storm meets the storm selection criteria), the field crew and analytical laboratory will be alerted by the monitoring task manager. Field crews will be given notice to mobilize when precipitation is imminent or has begun.

When first alerted, field crew members should consult their sampling plan and check monitoring equipment and supplies to ensure they are ready to conduct monitoring. Upon arrival at the monitoring site, the field crew should:

- Install clean composite bottle(s) and remove lid(s) as necessary.
- Check battery levels.
- Check tubing and all connections.
- Add ice to sampler if necessary.
- Program automatic flow meter and sampler.

If sample collection is conducted at a station without a refrigerated sampler, or if grab samples are required, the field crew will need to obtain frozen refreezable ice packets or purchase fresh ice (for sample preservation) on the way to the sampling station. Composite sample bottles are required to be kept in a refrigerated sampler, or surrounded with ice during sample collection. Ice for grab samples should be kept in ice chests where full grab sample bottles will be placed.

5.5.8 Programming Automated Equipment

Most automated monitoring stations typically contain continuous flow measurement devices and data logging software. To collect flow-proportioned composite samples, the flow measurement device must be programmed to send a pulse to the sampler each time a specified flow volume has passed the flow sensor. The sampler, in turn, is programmed to collect a sample each time it receives a pulse. Therefore, each time the programmed flow volume per sample has passed the sampling location, a composite sample aliquot is collected.

The flow volume per sample (the amount of flow that passes the sampling point between each aliquot collected) must be programmed into the flow meter in proportion to the predicted rainfall amount for each storm event, to set the sample pacing so as to fill the composite bottle(s) at an appropriate rate.

The automatic sampler should be programmed to collect a specific number of composite sample aliquots of specific volume before halting the sampling program, so as to fill the composite bottle(s) to the desired level, without overfilling.

The number of composite sample aliquots (CSA) may be determined based on total composite sample volume required and the desired sample aliquot volume. An adequate number of sample aliquots should be collected to produce a composite sample that is representative of the runoff for the entire sampling event. The total sample volume required for the laboratory to conduct all

planned analyses, including QA/QC analyses, may be divided by the selected sample aliquot volume to produce the required sample aliquot number.

Detailed methods for programming automated sampling equipment to capture the right amount of flow and number of composite sample aliquots is specified in the *Caltrans Guidance Manual: Stormwater Monitoring Protocols* (LWA, 1997).

5.5.9 Overlapping Storms

The following language is applicable to any BMP that will hold water for longer than 48 hours, e.g., extended detention basins. Declaring the end of a storm event may be difficult as the BMP may hold water for longer than 48 hours and effluent flow may continue out of the basin. Thus, storm events can overlap. If storm events begin to overlap, two criteria will be used to either continue sampling or end sampling. If the effluent has 75% storm capture or more and 8 or more sample aliquots, monitoring will stop and the stations will be shut down. If the effluent has less than 75% storm capture or less than 8 sample aliquots, the influent and effluent sampling will continue monitoring the event until the rain event stops.

5.6 Laboratory Sample Preparation and Analytical Methods

This section describes the steps to be taken by analytical laboratories to prepare for monitoring events, and the procedures laboratories will use for stormwater sample analyses. For Brown and Caldwell, Del Mar Analytical is the contracted laboratory. Law Crandall uses Montgomery Watson Laboratories, Pat-Chem Laboratories, and Quanterra.

5.6.1 Pre-Sampling Preparations

The analytical laboratory will be involved in a number of activities prior to the actual analysis of stormwater samples. These activities are described below.

Determination of Laboratory Performance Criteria

The analytical laboratory must analyze the stormwater samples using methods that will achieve Caltrans' data quality objectives (DQOs) for the project. The contract for analytical services should specify laboratory performance criteria designed to ensure that the project DQOs will be met. The contract should specify the following:

- Analytical detection limits
- Holding times
- Types and frequency of QA/QC analyses
- Quality control performance limits
- Sample turnaround times
- Electronic and hard copy report formats
- Corrective action procedures

In addition, the contract with the laboratory should specify that at least 90% of the stormwater sample results must meet the QA/QC criteria and be deemed usable for the project.

Laboratory Input to Project QA/QC Plan

The contract laboratory should review and provide input to the QA/QC plan for each BMP site. This input will help ensure that the QA/QC plan specifies the correct sample containers, sample volumes, holding times, analytical methods, detection limits, reporting/quantity limits, and the correct points of contact for communications between field and laboratory personnel. In addition, the laboratory should be involved early in the process so they can provide feedback on methods and performance standards during the planning phase.

Sample Containers, Blank Water

Each analytical method has specific requirements for type of sample container (e.g., plastic, glass, Teflon, amber glass), and the size and number of containers. Table 5.1 shows the appropriate sample containers for the analytical constituents recommended for the monitoring program.

Each laboratory may have its own sample container requirements, which may be slightly different from those listed in Table 5.1. As noted above, the analytical laboratory should review the QA/QC plan for each site to ensure that it specifies the appropriate sample containers, volumes, and preservatives. Sampling personnel will need to request the appropriate containers from the laboratory before each sampling event.

For the BMP sites where composite samples will be collected, field personnel must obtain the appropriate composite sample containers from the laboratory; however, the field personnel do not need the individual containers required for each analysis. The composite sample bottle container must be large enough to provide sufficient volume of sample for all of the individual constituents to be analyzed. The container type should be compatible with all of the constituents. In general, borosilicate glass is the most appropriate material for composite sample containers.

For collection of grab samples, field personnel must obtain the appropriate pre-cleaned bottles from the laboratory prior to the sampling event. Some projects may require use of “ultra-clean” techniques (USEPA, 1995) in order to meet the project DQOs. Such techniques may entail use of special cleaning procedures for the sample containers, which should be specified in the contract for analytical services and the QA/QC plan for the project, to ensure that the containers obtained from the laboratory have been cleaned in accordance with the EPA guidance.

Sample volumes necessary for the requested analyses should be confirmed with the laboratory prior to sample collection, including sufficient sample volumes for the required laboratory QA/QC analysis. Laboratory QA/QC samples that make use of sample water provided by the field crew include splits (laboratory duplicates), matrix spikes, and matrix spike duplicates. Additional sample water will also be required for field duplicate QA/QC samples.

If field blanks are to be collected, the laboratory also will need to provide sufficient quantities of deionized water and appropriate containers. The deionized water supplied by the laboratory should be the same as the water used for equipment cleaning.

Table 5.1 lists the sample volume requirements for the analytical constituents.

Laboratory Coordination Prior to a Sampling Event

It is important for the task manager to notify the laboratory of an anticipated storm sampling event so that the laboratory can prepare for possible off-hour sample delivery, and to set up for any analyses with short holding times. The laboratory contact should be notified regarding the number of samples anticipated, approximate date and time of sampling (if known), and when sample containers, blank water or ice chests will be required.

In addition, the laboratory should be made aware of specific project requirements such as required laboratory performance objectives, required QA/QC samples, and reporting requirements.

5.6.2 Sample Storage and Handling Prior to Analysis

To minimize the chance of sample contamination and unreliable analytical results, special measures must be taken during the storage and handling of samples prior to analysis. For example, samples must be collected and stored in the appropriate containers and preserved. If composite samples are collected, sample splitting must be conducted to properly store and preserve the samples. In addition, some analytical methods require filtration of the sample prior to analysis. Finally, samples must be analyzed within established holding times to ensure reliability of the results. Each of these measures is discussed in more detail below.

Composite Splitting

As mentioned above, composite samples must be split prior to analysis. It is recommended that composite sample splitting be conducted by the analytical laboratory to minimize the chance of contamination. If composite splitting is conducted in the field, clean techniques should be used.

Sample Filtration

Sample filtration is required when collecting samples for dissolved metals determinations. It is recommended that filtration for metals be conducted by the analytical laboratory to reduce the potential for contamination in the field, especially during storm conditions. EPA Method 1669 (*Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels*) specifies the use of a 0.45 µm, 15 mm diameter or larger, tortuous-path capsule filter or equivalent. To minimize phase change from the time of sample collection to the time of analysis, it is essential that the laboratory perform the sample filtration promptly. The field crew should therefore specify "filter for dissolved metals immediately upon receipt" on the sample chain-of-custody form, and coordinate this activity with the laboratory in advance.

Sample Preservation

Chemical preservatives are added to the samples for certain analyses to prolong the stability of the constituents during storage. Table 5.1 lists the sample preservatives for recommended and additional analytical constituents. No preservatives are added to the composite sample containers because no single chemical preservative is suitable for all of the constituents. The laboratory must first divide the composite sample into the appropriate bottle for each analysis, and then add chemical preservatives as appropriate for each analysis. If grab sampling procedures are used (i.e., field personnel directly fill the containers required for each analysis), the laboratory should add the appropriate preservative to each sample container immediately upon receipt at the laboratory. Use of bottles pre-filled with preservative is not recommended as this may increase logistical problems (e.g., field crews have to avoid loss of preservative when collecting samples).

Holding Times

Holding times are specified for various analytical methods and analytes. The holding time starts when sample collection is complete and is counted until extraction/preparation or analysis of the sample. For composite samples, the time of the initial sample aliquot is considered the "sample collection time" for determining sample holding time. If a sample is not analyzed within the designated holding times, the analytical results may be suspect. Thus, it is important that the laboratory meet all specified holding times and make every effort to prepare and analyze the samples immediately after they are received. Prompt analysis also allows the laboratory time to review the data and, if analytical problems are found, re-analyze the affected samples.

Table 5.1 lists the analytical holding times for the analytical constituents recommended for monitoring. Some of these holding times are short and will require the laboratory to immediately handle the sample once received. For example, the fecal coliform test must be started within 6 hours of sample collection. Similarly, soluble reactive phosphorus or nitrite analyses must be performed within 48 hours after sample collection. Holding times may be a factor affecting allowable sampling times if the laboratory has not agreed to work evenings or weekends.

5.6.3 Laboratory Data Package Deliverables

As a part of the laboratory contract, the data package that will be delivered to Caltrans and the timing of its delivery (turn around time) will be defined. The data package should be delivered in hard copy and electronic copy (on diskette). See technical memorandum on "Caltrans Data Management Plan – Data Reporting Protocol and Database," Doc. I.D. CTSW-TM-98-005, for details of Caltrans data management program (see Appendix E-3).

The hard copy data package will include a narrative which outlines any problems, corrections, anomalies, and conclusions, as well as completed chain of custody documentation. A summary of the following QC elements must be in the data package: sample extract and analysis dates, results of method blanks, summary of analytical accuracy (matrix spike compound recoveries, blank spike compound recoveries, surrogate compound recoveries), summary of analytical precision (comparison of laboratory split results and matrix spike duplicate results, expressed as relative percent difference), and reported detection limits. For all total petroleum hydrocarbon analy-

ses, the gas chromatograms of station samples, QC samples, blanks, and standards should be requested as described above.

In addition to the hard copy, an electronic copy of the data should be requested from the laboratory, including all of the information found in the hard copy data package except for TPH chromatograms. The contractors will adopt a standard format for submission of the electronic copy and will then submit it for inclusion in a database of all Caltrans stormwater data.

Common turnaround times for laboratory data packages are two to three weeks for faxed data and three weeks to thirty days for hard copy and electronic copy. Receiving the faxed data quickly allows for an early data review to identify any problems that may be corrected through sample re-extraction or re-analysis.

5.7 Sample Custody

Equipment and bottles used in the collection of samples to be analyzed for trace metals, trace organics, nutrients, and bacteriological constituents must be handled with great care to minimize the possibility of contamination. The following procedures include sample handling techniques that maximize the ability of sampling personnel to collect samples reliably and with minimal sample contamination.

All samples must be kept on ice, or refrigerated, from the time of onset of sample collection to the time of receipt by laboratory personnel. If samples are being shipped to the laboratory, place sample bottles inside coolers with blue ice, ensure that the sample bottles are well packaged (i.e., with bubble wrap, foam, etc.), and secure cooler lids with packaging tape. Note that packing with regular ice will lead to objects shifting once ice has melted. Dry ice is forbidden by shipping companies.

It is imperative that all samples be analyzed within the maximum holding times specified by laboratory analytical methods. To minimize the risk of exceeding the holding times, stormwater samples must be transferred to the analytical laboratory as soon as possible after sampling is complete. Moreover, the laboratory should be notified before the sampling begins so that it can prepare to analyze the samples immediately upon receipt.

The sampling team must fill out chain-of-custody (COC) forms (see example on following page) for all samples submitted to the analytical laboratory. The purpose of the forms is to keep a record of the transfer of sample custody and requested analyses. Sample date, location, and analysis requested are noted on each COC, including specification of lab quality control requirements (e.g., laboratory duplicate samples and matrix spike/matrix spike duplicate (MS/MSD) samples. Any special instructions for the laboratory should also be noted, for example, requesting that filtration for dissolved metals be conducted immediately. Copies of COC forms are kept with field notes in a field log book. COC forms should be checked to be sure all analyses specified by the sampling plan are included. Review of the COC forms immediately following a storm event gives the data reviewer a chance to review the field crews' requests and then to notify the laboratory of additional analyses or necessary clarification.

Chain-of-Custody Form

Laboratory:	Lab # _____ Date Rec'd _____	**From:**
Project: **P.O.#:**	**Project #:** **Required Completion Date:**	

Sample ID #	**Site ID #**	**Lab ID #**	**Matrix/ Analysis**	**Containers**	**Pres.**	**Sample Date/Time**		**Condition Upon Receipt**

Data Reports **WILL** include the following: Sample/Site ID, Analytical Method, Detection Limit, Date of Extraction if applicable, Date of Analysis, Analytical Results and Signature of QA Reviewer.

Special Instructions/Comments:

Relinquished By: Date/Time	Transporter	Received By: Date/Time
Relinquished By: Date/Time	Transporter	Received By: Date/Time
Relinquished By: Date/Time	Transporter	Received By: Date/Time

5.8 Groundwater Monitoring

5.8.1 Applicable BMPs

Groundwater monitoring in District 7 applies to only two sites, an infiltration trench and infiltration basin. The infiltration trench will be located at the Altadena Maintenance Station, while the infiltration basin will be located at the I-605/SR-91 interchange. These facilities are designed to retain a known volume of runoff and allow that runoff to slowly percolated to the groundwater table.

5.8.2 Sampling Frequency

Current plans call for two baseline-sampling episodes at each well location. The first baseline sampling will be conducted prior to construction of the BMPs. The second baseline-sampling episode will take place immediately after construction of the BMPs. Post-construction sampling frequency will consist of two samples per year, in December and February.

5.8.3 Sampling Equipment and Methods

Infiltration Basins: The sampling method depends on the depth to groundwater at the site. The infiltration basin located in District 7 has a depth of greater than 10 m. In this case, the samples will be collected from the vadose zone using a pressure-vacuum lysimeter. The lysimeter will be installed according to the manufacturer's recommendations and placed so that samples are collected at a depth of 1–2 m (3–6 ft) below the basin floor. This type of sampling is only appropriate for the analysis of dissolved constituents, because the water must be drawn through a ceramic or Teflon cup.

Core samples in the infiltration basin will be collected to determine the rate at which constituents are transported into the subsurface. Samples of soil will be collected from depths of 0.3 m and 0.6 m (1 ft and 2 ft) in the infiltration basin and analyzed for zinc, lead, copper, and total petroleum hydrocarbons. Similar samples will also be collected and analyzed immediately following completion of construction for comparison. There will be no sampling of the influent to the infiltration basin.

Infiltration Trench: Water quality samples will be collected from the vadose zone below the trenches since the water table is at least 10 m below the bottom of the trench at each of the pilot project sites. This type of sampling requires a pressure-vacuum lysimeter. The lysimeter will be installed according to the manufacturer's recommendations and placed so that samples are collected at a depth of 1–2 m (3–6 ft) below the trench floor. This type of sampling is only appropriate for the analysis of dissolved constituents, in this case dissolved metals, because the water must be drawn through a ceramic or Teflon cup.

5.8.4 Sample Handling

All sample containers will be iced immediately and preserved appropriately. Chain-of-custody forms will be completed and will accompany the samples during transport to the appropriate laboratories for analysis.

5.8.5 Analytical Constituents

Constituents selected for analysis of the baseline quality of the groundwater, EPA method numbers, and method detection limits are listed in Table 5.2. The constituent list that was provided in the District 7 Scoping Study was used as a basis for the selection. A few basic conventional parameters were added to better characterize the groundwater. Hardness was included because it is a critical parameter for interpretation of metal toxicity in water. Other general parameters added were TDS, and COD. Because bacteria is a critical stormwater permit parameter for Caltrans, and because such contamination can come from many sources, bacterial parameters were included.

Table 5.2
Selected Analytical Constituents for Baseline Groundwater Monitoring

Analyte	Analytical Procedure	Reporting Limits
Conventionals		
COD	EPA 410.1	8 mg/L
Hardness	EPA 130.2	1 mg/L
TDS	EPA 160.1	1 mg/L
TSS	EPA 160.2	1 mg/L
Specific Conductance	EPA 120.1	2.0 µmho/cm
pH	EPA 150.1	0.1 units
Nutrients		
Nitrate	EPA 300.0	0.2 mg/L
TKN	EPA 351.3	1.0 mg/L
Total Phosphorus	EPA 365.3	0.03 mg/L
Total and Dissolved Metals		
Copper	EPA 200.8/6020	1 µg/L
Lead	EPA 200.8/6020	1 µg/L
Zinc	EPA 200.8/6020	5 µg/L

Table 5.2 (continued)

Analyte	Analytical Procedure	Reporting Limits
Organics		
Total Petroleum Hydrocarbons as Diesel	EPA 8015A	100 µg/L
Total Petroleum Hydrocarbons as Gasoline	EPA 8015A	200 µg/L
Bacteria		
Total Coliform	SM 9221	2 MPN/100 mL
Fecal Coliform	SM 9221E	2 MPN/100 mL

Sources: Larry Walker and Associates, *Guidance Manual: Stormwater Monitoring Protocols*, Section 4. 1997; and RBF, *Scoping Study, Retrofit Pilot Program Caltrans District 7, April 1998* [and *District 11, February 1998*].

5.9 Empirical Observations

5.9.1 Purpose

The constituent removal for some of these devices is well established for properly designed and maintained systems. Therefore, much of the effort of this study will be directed to recording and analyzing the siting, design, construction, and operation and maintenance experience. Forms have been developed for each phase of the project so that engineers and support staff can record their observations in a common format to facilitate compilation of this information.

5.9.2 Parameters and Guidelines for Storm and Dry Weather Observations

A site visit log will be filled out when visiting each site. The types of observations recorded in the site visit log will vary with the type of BMP being evaluated. Log forms are provided in Volume II of this manual. Some of the site-specific observations are described below. However, for a list of observations that are *required* to be made at each BMP type, Appendix E-2 provides a matrix with this information.

Drain Inlet Inserts

- Evidence of litter and debris clogging insert or inlet
- Frequency of litter and debris removal
- Frequency insert must be replaced
- Evidence of flow bypass during storms
- Evidence of resuspension of trapped material
- Unusual or unpleasant odors

Oil/Water Separators

- Change in litter accumulation and location since previous visit
- Condition/clogging of coalescing plates
- Evidence of free oil in control
- Frequency of litter, debris and oil removal
- Unusual or unpleasant odors
- Observation of inflow and outflow to see if water appears to be getting cleaner

Extended Detention Basins

- Water level to determine rate of stormwater infiltration
- Visual evidence of short circuiting (for wet weather visits)
- Description of amount and location of sediment accumulation in basin
- Evidence of scouring or resuspension near basin inlet
- Predominant type of litter found in basin
- Change in litter accumulation and location since previous visit
- Condition/clogging of outlet structure
- Evidence of erosion in natural channels below basin outfall
- Condition of basin floor/ formation of low areas with permanent pools
- Degree and type of vegetation establishment in the basin
- Stability of basin slopes/evidence of erosion
- Condition of vegetation surrounding basin
- Evidence of vandalism of equipment or basin structures
- Presence of unpleasant odors
- Observation of inflow and outflow to see if water appears to be getting cleaner

Infiltration Basins

- Water level to determine rate of stormwater infiltration
- Description of amount and location of sediment accumulation in basin
- Annual measurement of depth of accumulated material in the basin
- Sediment samples must be collected from the surface of the infiltration basin & analyzed for particle size distribution, metals and TPH
- Evidence of scouring or resuspension near basin inlet
- Predominant type of litter found in basin
- Change in litter accumulation and location since previous visit
- Condition of basin floor/formation of low areas so infiltration restricted to small areas
- Qualitative description of soil saturation during dry weather
- Degree and type of vegetation establishment in the basin
- Stability of basin slopes/evidence of erosion
- Condition of vegetation surrounding basin
- Evidence of vandalism of equipment or basin structures
- Presence of unpleasant odors

Infiltration Trenches

- Water level to determine rate of stormwater infiltration
- Description of amount and location of sediment accumulation in basin
- Evidence of scouring or resuspension near basin inlet
- Predominant type of litter found in basin
- Change in litter accumulation and location since previous visit
- Condition of basin floor/formation of low areas so infiltration restricted to small areas
- Qualitative description of soil saturation during dry weather
- Evidence of vandalism of equipment or basin structures
- Presence of unpleasant odors

Biofiltration Swales and Strips

- Condition/height of vegetation in the control
- Density of vegetation
- Document need for mowing, and other maintenance activities
- Predominant type of litter found in biofilter
- Change in litter accumulation and location since previous visit
- Change in the types and coverage of the selected vegetation
- Evidence of erosion or channelization in the control
- Evidence of standing water or other drainage problems
- Hydraulic residence time calculation
- Emergence of wetland characteristics
- Evidence of short circuiting during storm events
- Evidence that vegetation is flattened during storm events and species most susceptible
- Description of amount and location of sediment accumulation in the control
- Evidence of vandalism of equipment or basin structures
- Observation of inflow and outflow to see if water appears to be getting cleaner

Media Filters / Multi-Chambered Treatment Trains

- Water level
- Visual evidence of short circuiting (for wet weather visits)
- Description of amount of sediment accumulation in sedimentation chamber
- Depth of penetration of sediment into the media layer
- Evidence of scouring or resuspension near basin inlet
- Predominant type of litter found in basin
- Change in litter accumulation and location since previous visit
- Condition of media layer/formation of low areas so infiltration restricted to small areas
- Condition/clogging of flow structure between sedimentation and filtration basins
- Evidence of vandalism of equipment or basin structures

- Presence of unpleasant odors
- Observation of inflow and outflow to see if water appears to be getting cleaner

Continuous Deflective Separation (CDS) Units

- Water level in unit (needs to be maintained for proper functioning)
- Visual evidence of short circuiting (for wet weather visits)
- Description of amount and location of sediment accumulation in basin
- Predominant type of litter found in basin
- Change in litter accumulation since previous visit
- Frequency of litter and debris removal
- Evidence of vandalism of equipment or basin structures
- Observation of inflow and outflow to see if water appears to be getting cleaner

5.9.3 BMP Specific Checklists

Log forms in support of the Benefit Assessment Program will be developed for Volume II of this document. The observational and narrative description of the process will identify the problems encountered in siting, designing, constructing, operating and maintaining the facilities. In addition, it will document whether the design guidelines could be fully implemented and how guidelines affected BMP performance. An analysis of these data will form a central part of the final research report for each of the selected BMPs. Emphasis in the final reports will be placed on identifying solutions to problems discovered during the implementation of the pilot projects, and documenting procedures that were determined to be beneficial in maintaining the effectiveness of the BMP. (See Section 1.0 for a discussion of the benefit assessment program and report.)

5.10 Quality Assurance/Quality Control Data Evaluation

All data reported by the analytical laboratory must be carefully reviewed to determine whether the project's data quality objectives have been met. The procedure for evaluating the laboratory data, including the results of all QA/QC sample analysis, is described by LWA (1997). Those procedures will be adhered to in this study.

Corrective action is that taken when an analysis is deemed out of control for some reason. These include exceedences of the RPD ranges, of spike recoveries and of blanks. The corrective action varies somewhat from analysis to analysis, but typically involves the following:

- A check of procedure
- Documents and calculations to identify any possible error
- Correction of errors
- Like calculations to improve results
- Re-analysis of the sample extract, if available, to see if results can be improved
- Complete reprocessing and re-analysis of additional sample material, if available

5.11 Quality Assurance/Quality Control (QA/QC)

The accuracy and precision of analytical data are dependent on the way in which samples are collected, handled and analyzed. To ensure data quality, a QA/QC sampling plan, including both field and laboratory measures, should be developed prior to implementing the stormwater monitoring program. For USEPA requirements in developing quality assurance project plans see USEPA draft document "EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations – EPA QA/R-5" (November 1997). For guidance on data quality assessment see USEPA document "Guidance for Data Quality Assessment – Practical Methods for Data Analysis, EPA QA/G-9" (EPA/500/R-96/084, January 1998).

Each of the elements of a typical stormwater monitoring QA/QC program is described by LWA (1997). Volume II of this document contains a Quality Assurance Project Plan (QAPP).

5.12 Documentation and Reporting Requirements

A Sampling Plan and Standard Operating Procedures must be developed by each monitoring team. This will be included in Volume II of the Operation, Maintenance and Monitoring Plan.

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6.0 PROGRAM DOCUMENTATION

This section presents the requirements and usage of data collected throughout the two year operation, maintenance, and monitoring cycle. It is planned to develop a mid-year at the end of each year's wet season. Following the final wet season the data will be compiled to evaluate the benefits and experiences derived from the multi-year program.

6.1 Mid-Year Reports

The mid-year reports will present all of the data and recorded observations collected during the previous wet season, and will also include recommendations for study improvements for the ensuing year. The report will serve not only as a mid-year report but as a model for the final report, including the benefit assessment aspect of the program due at the end of the project.

A format for the mid-year report will be devised cooperatively with the Plaintiffs, and will include not only the OMM portion of the program but also the design and construction stages. The documentation for the OMM stage of the program will include compilation of the data and record of experience. Information anticipated is data and other information on stormwater characteristics, operation and maintenance, design and construction evaluation, empirical data, current costs, and recommendations for improving the program for the ensuing year.

Stormwater Data

Collection procedures and water quality parameters are established in Section 5.0 of this plan. The efficiency of each BMP will be calculated based on the methodology presented in the Scoping Studies for Caltrans Districts 7. The methodology is presented as Appendix F-1 of this plan.

The non-chemistry data which will be collected for each storm must include: date, time and duration of the storm; flow data such as maximum flow (quantity, day, time); stormwater volume; volume of storm sampled; etc.

All data will be entered into a central database for use in all reports. The database will capture both water quality data and empirical observations. A vector related database will be compiled and maintained by the California Department of Health Services.

BMP Operations

The operation and maintenance data will document the production of sediment, erosion problems, and actual frequency of maintenance activities as compared to the planned frequency. Critical to the documentation is analysis of the variation from planned frequency of all

maintenance functions. This will help determine the benefits of the BMPs and estimate future operation and maintenance requirements.

Visual observations such as: functioning of the inlet and outlet works, estimation of residence time, observations regarding "short circuiting;" and drain time for infiltration BMPs. Where failures appear imminent, the consultant must take immediate action to correct the failure and properly document the actions. The logs of empirical observation will become part of the permanent record and the analysis will be a vital portion of the Benefit Assessment and information for future deployment of the BMPs

6.1.3 BMP and Site Maintenance

Critical observations that need to be recorded are the deviations from the planned maintenance due to unusual weather conditions, site conditions, or failures in the BMP. The observer will record each initial field assessment of failures or deviations from expectations.

This data will be compiled in the program database. The operation and maintenance costs will be tracked in a separate database.

6.1.4 Design and Construction Evaluation

The data and observations will provide an opportunity for field evaluations of the design and construction. These observations will be recorded in the empirical data and analyzed by engineers. These analyses will become part of the experience record and ultimately the final or the benefit assessment. report.

6.1.5 Cost Summary

Costs are a critical element of the information collected. A standard reporting format for costs will be developed early in the monitoring program. The cost data will be compiled by each consultant. These costs will be provided to the Plaintiffs on an ongoing basis at status meetings.

6.2 Recommendations for Next-Year Program

As the data are compiled and observations are analyzed flaws in the OMM program may become apparent. Recommendations for improvements to all aspects of the program will be made for implementation in the ensuing wet year.

6.3 Final Report and Benefit Assessment

At the conclusion of the BMP Retrofit Program, a final report will be developed and prepared in cooperation with the Plaintiffs. Much of the effort of the BMP Program will be directed to recording and analyzing the siting, design, construction, and operation and maintenance experience phases of the project in support of the benefit assessment aspect of the program which will be integrated into the final report (see Section 1.0).

The benefit assessment will include the following subjects:

- Analysis of stormwater data
- Maintenance and operation program review
- Design and construction evaluation
- Analysis of empirical data
- Cost summary
- Overall BMP performance review and assessment

The benefit assessment report will be used to prepare a plan for submission to CSWRCB or RWQCB to address further retrofitting.

Appendix A

NOT APPLICABLE
NO SUPPORTING INFORMATION REQUIRED FOR SECTION 1.0

Appendix B-1

Construction Inspection Forms

Infiltration Basin Construction Inspection Report Form

Adapted from the State of Maryland Inspector's Guidelines Manual

Date _____ Time _____

Project _____

Location _____

Individual Contacted _____

Site Status _____ (active, inactive, completed)

1. Pre-construction

	Satisfactory	Unsatisfactory
Runoff diverted	_____	_____
Area stabilized	_____	_____

2. Excavation

Size and location	_____	_____
Side slope stable	_____	_____
Soil Permeability	_____	_____
Groundwater Bedrock	_____	_____

3. Embankment

Cut-off trench	_____	_____
Fill material	_____	_____

4. Final Excavation

Drainage area stabilized	_____	_____
Sediment removed from facility	_____	_____
Basin floor tilled	_____	_____
Facility stabilized	_____	_____

5. Final Inspection

Pretreatment facility in place	_____	_____
Inlets/outlets	_____	_____
Site stabilization	_____	_____
Access to facility provided	_____	_____

Action to be taken:

No action necessary. Continue routine inspections _____

Correct noted site deficiencies by _____

1st notice _____

2nd notice _____

Submit plan modifications as noted in written comments by _____

Notice to Comply issued _____

Final inspection, project completed _____

Infiltration Trench Construction Inspection Report Form

Adapted from the State of Maryland Inspector's Guidelines Manual

Date _____ Time _____

Project _____

Location _____

Individual Contacted _____

Site Status _____ (active, inactive, completed)

1. Pre-construction

	Satisfactory	Unsatisfactory
Runoff diverted	_____	_____
Area stabilized	_____	_____

2. Excavation

Size and location	_____	_____
Side slope stable	_____	_____
Soil Permeability	_____	_____
Groundwater Bedrock	_____	_____

3. Filter Fabric Placement

Fabric specification	_____	_____
Placed on bottom, sides, and top	_____	_____

4. Aggregate Material

Size as specified	_____	_____
Clean washed material	_____	_____
Placed properly	_____	_____

5. Observation Well

Pipe size	_____	_____
Removable cap footplate	_____	_____
Initial depth = _____ ft.	_____	_____

6. Final Inspection

Pretreatment facility in place	_____	_____
Stabilization	_____	_____
Outlet	_____	_____

Action to be taken:

No action necessary. Continue routine inspections _____

Correct noted site deficiencies by _____

1st notice _____

2nd notice _____

Submit plan modifications as noted in written comments by _____

Notice to Comply issued _____

Final inspection, project completed _____

Filtration Facility Construction Inspection Report Form

Date _____ Time _____

Project _____

Location _____

Individual Contacted _____

Site Status _____ (active. inactive. completed)

1. Pre-construction

	Satisfactory	Unsatisfactory
Runoff diverted	_____	_____
Facility diverted	_____	_____
Facility location staked out	_____	_____

2. Excavation

Size and location	_____	_____
Side slopes stable	_____	_____
Foundation cleared of debris	_____	_____
Foundation area compacted	_____	_____

3. Structural Components

Dimensions and materials	_____	_____
Forms adequately sized	_____	_____
Concrete meets standards	_____	_____
Prefabricated joints sealed	_____	_____
Underdrains (size. materials)	_____	_____

4. Completed Facility Components

24 hour water filled test	_____	_____
Contributing area stabilized	_____	_____
Filter material per specification	_____	_____
Underdrains installed to grade	_____	_____

5. Final Inspection

Dimensions	_____	_____
Structural Components	_____	_____
Proper outlet	_____	_____
Effective site stabilization	_____	_____

Action to be taken:

No action necessary. Continue routine inspections _____

Correct noted site deficiencies by _____

1st notice _____

2nd notice _____

Submit plan modifications as noted in written comments by _____

Notice to Comply issued _____

Final inspection. project completed _____

Biofiltration Construction Inspection Report Form

Date _____ Time _____

Project _____

Location _____

Individual Contacted _____

Site Status _____ (active, inactive, completed)

1. Pre-construction

	Satisfactory	Unsatisfactory
Runoff diverted	_____	_____
Facility area cleared	_____	_____
Facility location staked out	_____	_____
Facility not in heavily shaded area	_____	_____

2. Excavation

Size and location	_____	_____
Lateral slopes completely level	_____	_____
Longitudinal slopes within design range	_____	_____

3. Check dams and Level Spreaders

Dimensions, spacing, and materials	_____	_____
Compaction	_____	_____
Level spreaders are completely level	_____	_____

4. Structural Components

Inlets and outlets installed correctly	_____	_____
Flow bypasses installed correctly	_____	_____
Pretreatment devices installed	_____	_____
Curb cuts installed per plans	_____	_____

5. Vegetation

Complies with planting specs.	_____	_____
Topsoil adequate in composition and placement	_____	_____
Adequate erosion control measures in place	_____	_____

6. Final Inspection

Dimensions	_____	_____
Check dams and level spreaders	_____	_____
Proper outlet	_____	_____
Effective stand of vegetation and stabilization	_____	_____
Construction generated sediments removed	_____	_____

Action to be taken:

No action necessary. Continue routine inspections _____

Correct noted site deficiencies by _____

1st notice _____

2nd notice _____

Submit plan modifications as noted in written comments by _____

Notice to Comply issued _____

Appendix B-2

Maintenance Inspection Report Forms

Filtration Facility Maintenance Inspection Report Form

Date _____ Time _____

Project _____

Location _____

Individual Conducting the Inspection_____"As Built" Plans available Y/N_____

Warning: If filtration facility has a water tight cover; be careful regarding the possibility of flammable gases within the facility. Care should be taken lighting a match or smoking while inspecting facilities that are not vented.

Inspection frequency shown in parentheses after item being considered

		Satisfactory	Unsatisfactory
1. Debris cleanout	(Monthly)		
Contributing areas clean of debris		_____	_____
Filtration facility clean of debris		_____	_____
Inlets and outlets clear of debris		_____	_____
2. Vegetation	(Monthly)		
Contributing drainage area stabilized		_____	_____
No evidence of erosion		_____	_____
Area mowed and clippings removed		_____	_____
3. Oil and grease	(Monthly)		
No evidence of filter surface clogging		_____	_____
Activities in drainage area minimize oil & grease entry		_____	_____
4. Water retention where required	(Monthly)		
Water holding chambers at normal pool		_____	_____
No evidence of leakage		_____	_____
5. Sediment deposition	(Annual)		
Filtration chamber clean of sediments		_____	_____
Water chambers not more than ½ full of sediments		_____	_____
6. Structural components	(Annual)		
No evidence of structural deterioration		_____	_____
Any grates are in good condition		_____	_____
No evidence of spalling or cracking of structural parts		_____	_____
7. Outlets/overflow spillway	(Annual)		
Good condition, no need for repair		_____	_____
No evidence of erosion (if draining into a natural channel)		_____	_____

Inspection Frequency Key Annual, Monthly, After major storm

8. Overall function of facility (Annual)	Satisfactory	Unsatisfactory
No evidence of flow bypassing facility	_____	_____
No noticeable odors outside of facility	_____	_____

Inspection Frequency Key Annual, Monthly, After major storm

Action to be taken:

If any of the answers to the above items are checked unsatisfactory, a time frame shall be established for their correction or repair.

No action necessary. Continue routine inspections _____
Correct noted facility deficiencies by _____

Facility repairs were indicated and completed. Site reinspection is necessary to verify corrections or repairs.

Site reinspection accomplished on _____

Site reinspection was satisfactory. Next routine inspection is scheduled for approximately:

_____ _____
Signature of Inspector

Infiltration Basin Maintenance Inspection Report Form

Date _____ Time _____

Project _____

Location _____

Individual Conducting the Inspection_____"As Built" Plans available Y/N_____

Inspection frequency shown in parentheses after item being considered

		Satisfactory	Unsatisfactory
1. Debris cleanout	(Storm related)		
Basin bottom clear of debris		_____	_____
Inlet clear of debris		_____	_____
Outlet clear of debris		_____	_____
Emergency spillway clear of debris		_____	_____
2. Sediment traps or forebays	(Annual)		
Obviously trapping sediment		_____	_____
Greater than 50% of storage volume remaining		_____	_____
3. Vegetation	(Monthly)		
mowing done when needed		_____	_____
Fertilized per specifications		_____	_____
No evidence of erosion		_____	_____
4. Dewatering	(Weekly)		
Basin dewaters between storms		_____	_____
5. Sediment cleanout of basin	(Annual)		
No evidence of sedimentation in basin		_____	_____
Sediment accumulation does not yet require cleanout		_____	_____
6. Inlets	(Annual)		
Good condition		_____	_____
No evidence of erosion		_____	_____
7. Outlets/overflow spillway	(Annual, After Major Storm)		
Good condition, no need for repair		_____	_____
No evidence of erosion		_____	_____
8. Structural repairs	(Annual, After Major Storm)		
Embankment in good repair		_____	_____
Side slopes are stable		_____	_____
No evidence of erosion		_____	_____

Inspection Frequency Key Annual, Monthly, After major storm

9. Fences/access repairs (Annual)

	Satisfactory	Unsatisfactory
Fences in good condition	_____	_____
No damage which would allow undesired entry	_____	_____
Access point in good condition	_____	_____
Locks and gate function adequate	_____	_____

Inspection Frequency Key Annual, Monthly, After major storm

Action to be taken:

If any of the answers to the above items are checked unsatisfactory, a time frame shall be established for their correction or repair.

No action necessary. Continue routine inspections _____
Correct noted facility deficiencies by _____

Facility repairs were indicated and completed. Site reinspection is necessary to verify corrections or improvements.

Site reinspection accomplished on _____

Site reinspection was satisfactory. Next routine inspection is scheduled for approximately:

_____ _____
Signature of Inspector

Biofiltration Facility Maintenance Inspection Report Form

Date _____ Time _____

Project _____

Location _____

Individual Conducting the Inspection_____"As Built" Plans available Y/N_____

Inspection frequency shown in parentheses after item being considered

		Satisfactory	Unsatisfactory
1. Debris cleanout	(Storm dependent)		
Biofilters and contributing areas clean of debris		_____	_____
No dumping of yard wastes into biofilter		_____	_____
Litter (branches, etc.) have been removed		_____	_____
2. Vegetation	(Monthly)		
Plant height not less than design water depth		_____	_____
Fertilized per specifications		_____	_____
No evidence of erosion		_____	_____
Is plant composition according to approved plans		_____	_____
No placement of inappropriate plants		_____	_____
3. Dewatering	(Monthly)		
Biofilter dewaters between storms		_____	_____
No evidence of standing water		_____	_____
4. Check dams/energy dissipators/sumps	(Annual, After Major Storm)		
No evidence of sediment buildup		_____	_____
Sumps should not be more that 50% full of sediment		_____	_____
No evidence of erosion at downstream toe to drop structures		_____	_____
5. Sediment deposition	(Annual)		
Swale clean of sediments		_____	_____
Sediments should not be > than 20% of swale design depth		_____	_____
6. Outlets/overflow spillway	(Annual, After Major Storm)		
Good condition, no need for repair		_____	_____
No evidence of erosion		_____	_____
No evidence of any blockages		_____	_____
7. Integrity of biofilter	(Annual)		
Biofilter has not been blocked or filled inappropriately		_____	_____

Inspection Frequency Key Annual, Monthly, After major storm

Action to be taken:

If any of the answers to the above items are checked unsatisfactory, a time frame shall be established for their correction or repair.

No action necessary. Continue routine inspections _____
Correct noted facility deficiencies by _____

Facility repairs were indicated and completed. Site reinspection is necessary to verify corrections.

Site reinspection accomplished on _____

Site reinspection was satisfactory. Next routine inspection is scheduled for approximately:

_____ _____
Signature of Inspector

Infiltration Trench Maintenance Inspection Report Form

Date _____ Time _____

Project _____

Location _____

Individual Conducting the Inspection_____"As Built" Plans available Y/N_____

Inspection frequency shown in parentheses after item being considered

		Satisfactory	Unsatisfactory
1. Debris cleanout	(Monthly)		
Trench surface clear of debris		_____	_____
Inlet areas clear of debris		_____	_____
Inflow pipes clear of debris		_____	_____
Overflow spillway clear of debris		_____	_____
2. Sediment traps, forebays, or pretreatment swales	(Annual)		
Obviously trapping sediment		_____	_____
Greater than 50% of storage volume remaining		_____	_____
3. Vegetation	(Monthly)		
Mowing done when needed		_____	_____
Fertilized per specifications		_____	_____
No evidence of erosion		_____	_____
4. Dewatering	(Monthly)		
Trench dewaters between storms		_____	_____
5. Sediment cleanout of trench	(Annual)		
No evidence of sedimentation in trench		_____	_____
Sediments accumulation does not yet require cleanout		_____	_____
6. Inlets	(Annual)		
Good condition		_____	_____
No evidence of erosion		_____	_____
7. Outlets/overflow spillway	(Annual)		
Good condition, no need for repair		_____	_____
No evidence of erosion		_____	_____
8. Aggregate repairs	(Annual)		
Surface of aggregate clean		_____	_____
Top layer of stone does not need replacement		_____	_____
Trench does not need rehabilitation		_____	_____

Inspection Frequency Key Annual, Monthly, After major storm

	Satisfactory	Unsatisfactory
9. Vegetated surface (Monthly)		
No evidence of erosion	_____	_____
Perforated inlet functioning adequately	_____	_____
Water does not stand on vegetative surface	_____	_____
Good vegetative cover exists	_____	_____

Inspection Frequency Key Annual, Monthly, After major storm

Action to be taken:

If any of the answers to the above items are checked unsatisfactory, a time frame shall be established for their correction or repair.

No action necessary. Continue routine inspections _____
Correct noted facility deficiencies by _____

Facility repairs were indicated and completed. Site reinspection is necessary to verify corrections or improvements.

Site reinspection accomplished on _____

Site reinspection was satisfactory. Next routine inspection is scheduled for approximately:

_____ _____
Signature of Inspector

APPENDIX B-3

MAINTENANCE INDICATOR DOCUMENT

CALTRANS BMP RETROFIT PILOT PROGRAM

BMP MAINTENANCE INDICATORS

The following specific thresholds are for specified and implied criteria which "trigger" maintenance activities for specific BMPs. The maintenance activity shown is for those times when the field measurement exceeds the maintenance indicator. These thresholds do not preclude taking other actions needed to mitigate the given thresholds or taking actions needed to mitigate unanticipated problems. These indicators are not only for the BMP pilot program, but they are also considered representative of the long-term maintenance requirements for the BMPs.

This document covers routine maintenance. There may be occasions where emergencies arise, such as accidents, toxic spills, or other incidents, where critical response is needed. On those occurrences, Caltrans crews will respond to the emergency, on a priority basis and, if necessary, the BMP will be taken out of service until the BMP can be restored. The goal for such critical situations is to have the BMP back into service within 30 days.

The time period noted, for completion of any maintenance activity, is a goal that will depend on weather, access to the BMP, personnel and equipment availability.

BIOFILTER – STRIPS and SWALES
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
Uniform sheet flow over length of strip and across swale invert	Evidence of significant channeling or ponding	Visual inspection of erosion or major portions of flow discharge across strip/swale	Monthly, during target storms in the wet season	Correct channelized or ponded areas using additional fill and vegetation and/or by removing accumulated sediment. Target completion time is within 10 days.	None
Height of vegetation	Average plant height exceeds 10 inches	Visual inspection of vegetation throughout strip/swale	In October , and January and monthly during dry season	Cut plants to a average height of 6 inches and remove trimmings. Target completion within 10 days.	Palomar Airport Road Site: maximum average height is 13 inches; trim to 9 inches
Assess adequate vegetative cover	Less than 90 percent coverage in strip invert/swale or less than 70 percent on swale side slope	Visual inspection of strip/swale. Prepare a site schematic to record location and distribution of barren or browning spots to be restored. File the schematic for assessment of persistent problems.	Assess quantity needed in May each year	Re-sod barren spots during October/ November. Wet soil before and after sod is placed. Scarify area to be re-stored, to depth of 2-in.. Restore side slope coverage with hydroseed mixture. Irrigate same as saltgrass	Keep a reserve of approximately 10 percent of sodded surface area in saltgrass flats. Use mature flats to restore coverage. Order replacement material in May for delivery in September. Use original design erosion control seed mix on side slopes.

BIOFILTER – STRIPS and SWALES
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
Residence time is less that design criteria	Residence time is less than design criteria	Measure mean residence times in swale using protocol in OMM plan. Calculate residence time for design storm.	Once per year during target storm	Assess the cause of the problem. As soon as weather and moisture conditions allow, take corrective action. If sediment is the cause, in September, remove and dispose of accumulated sediment. Regrade to restore flow gradient. Resod by November 1	Swales only Cerritos MS – 4 min 605/91 – 9 min 5/605 – 7 min 605/Carson – 9 min Palomar – 14 min Melrose – 15 min
Inspect for debris accumulation	Vegetative debris, debris or litter present	Visual observation	Monthly	Remove litter, vegetative debris, and debris. Target completion period within 10 days.	None
Inspect for accumulated sediment	Sediment at or near plant height, channeling of flow, inhibited flow due to change in slope	Visual observation	Monthly during wet season	Remove sediment. If flow is channeled, determine cause and take corrective action. If sediment becomes deep enough to change the flow gradient, remove sediment, conduct sediment characterization according to OMM Plan Vol II, dispose of sediment, and replant. Regrade to design specification and replant swale/strip with sod. If	None

BIOFILTER – STRIPS and SWALES
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
				regrading is necessary, the process should start near May 1. Resod strip/swale in Nov. Target completion period within 10 days.	
Inspect for burrowing rodent activity	Ground squirrel holes, vole or gopher mounds	Visual observation	Monthly, for rodent activity with abatement immediately if the activity affects the performance of the BMP otherwise abate annually in September	• Where ground squirrels are active, firmly backfill the burrows to prevent seepage, erosion and leakage. • Where ground squirrels are not active, confirm that no owl activity is present (a biologist may be needed if uncertain). Firmly backfill the burrows to prevent seepage, erosion and leakage. • Where gophers are present, trap the gophers and level the mounds and firmly backfill the burrows to prevent seepage, erosion and leakage.	None

BIOFILTER – STRIPS and SWALES
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
				• Where voles are present, firmly backfill the burrows to prevent seepage, erosion and leakage • If ground squirrel abatement is needed conduct a one time poisoning program. After the appropriate amount of time has passed (determined by the pesticide applicator), firmly backfill the burrows to prevent seepage, erosion and leakage.	
Inspect for possible endangered species, threatened species and species of special concern within the BMP maintenance perimeter	Evidence of ponding, emergence of wetland or woody vegetation, shrubs, dwarf plantain, or burrowing animal damage. Presence of logs, woodpiles rocks, or large debris.	Visual observation	Weekly, during the wet season	• Remove woody vegetation, shrubs, dwarf plantain, pickleweed, woody wetland vegetation[3], and large debris within strip/swale within 10 days. • Correct ponded areas using sand fill within 3 days.	Vulnerable sites are: SR-78/Melrose I-5/Palomar Airport Rd

BIOFILTER – STRIPS and SWALES
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
				• If burrows are found between Mar 1 and Aug 30, a biologist needs to confirm that no birds are nesting in the burrow before sealing the hole. • At vulnerable sites, remove debris, woodpiles etc. within 10 days.	
Inspect for standing water	Water accumulation in spreader ditch or any structure	Standing water in spreader ditch or any structure	Annually, May 1	Where gravity draining is possible, drain the standing water	None
General Maintenance Inspection	Inlet structures, outlet structures, side slopes or other features damaged, significant erosion, emergence of trees, woody vegetation or weeds, fence damage, etc.	Visual observation	Monthly	Take action as needed to correct problems. Target completion period within 30 days.	Remove any trees, woody vegetation, or weeds taller than 12-inches.

DRAIN INLET INSERTS – STREAM GUARD

Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
Sediment removal	Sediment more than 6-inches	Visual inspection of sediment collected within insert	• Before each target storm event • Weekly during extended wet periods • Monthly during periods of dry weather	Replace insert. Target completion period within 10 days.	None
Inspect for debris/trash	Sufficient debris/trash that could interfere with proper functioning of insert	Visual observation	• Before and once during each target storm event • Weekly during extended wet periods	Remove and dispose of debris/trash. Target completion period within 1 day.	None
Oil and grease removal	Evidence of oily sheen in insert or downstream monitoring vault	Visual observation	During each target storm event and monthly during the dry season	Within 10 working days, replace oil absorbent polymer	None
Inspection for structural integrity	Improper installation, rips, tears, or other loss of structural integrity	Visual observation	Monthly	Replace insert or immediately consult with design engineer to develop course of action, effect repairs within 10 working days	None
Annual renewal of medium	End of wet season, April 30	None	Annually	Remove media and analyze for parameters shown in OMM Plans. Replace media before Oct 1	None

DRAIN INLET INSERTS – FOSSIL FILTER
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
Inspect for debris/trash	Sufficient debris/trash that could interfere with proper functioning of insert	Visual observation	• Before and once during each target storm event • Weekly during extended wet periods • Monthly during the dry season	Remove and dispose of debris/trash. Target completion period within 1 day.	None
Oil and grease removal	Absorbent granules dark gray, or darker, or unit clogged with sediment.	Visual observation	• At the end of each target storm event • Weekly during extended wet periods • Monthly during the dry season	Replace Fosil Filter™ trough within 10 working days.	None
Inspection for structural integrity	Broken or otherwise damaged insert	Visual observation	Monthly	Replace insert or immediately consult with design engineer to develop a course of action, effect repairs within 10 working days	None
Annual renewal of medium	End of wet season, April 30	None	Annually	Remove media and analyze for parameters shown in OMM Plans. Replace media before Oct 1	None

EXTENDED DETENTION BASINS
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
Drain time is 72 hours for design volume	Less than 48 hours or more than 72 hours for full basin	Determine drain time based on effluent flow meter activity or visual observation	Immediately after each target storm	• If time too long, open gate to discharge remaining volume, within 1 day. Per direction from design engineer, modify holes on standpipe after basin drains, within 30 days • Remove and dispose of debris/trash from outlet/outlet screen, within 10 days.	• Does not apply to District 7 Extended detention Basins • Clean rip-rap and standpipes in District 7
Basin side slope planted for erosion protection and planted invert	Average plant height greater than 18-inches	Visual observation and random measurements through out the side slope area	Monthly	Cut vegetation to an average height of 12-inches and remove trimmings. May cut to 8 inches after July 1. Target completion period within 30 days Do not cut more than four times per year,	None
Inspect for adequate vegetative cover	Less than 70 percent coverage on invert and side slopes	Visual observation	October each year	Hydroseed barren spots by Nov 1, scarify surface if needed.	
Inspect for possible vector harborage	Standing water for more than 72 hours	Visual observation	Monthly and 72 hours after target storm event	Immediately notify VCD for vector abatement assessment	None
Inspection for trash and	Debris/trash present	Visual observation	Monthly and before	Remove and dispose of	None

EXTENDED DETENTION BASINS
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
debris at inlet and outlet structures			every target storm	trash and debris Target completion period within 10 days.	
Inspection for sediment management and characterization of sediment for removal	• Sediment depth averages 18-inches or 10 percent of basin volume which ever is less • Any parameter concentration (See Table 5.2, Vol II) exceeds 50% of Title 22 TTLC. Or, if the parameter concentration falls between 10X STLC and TTLC, is less than 50% TTLC, and the WET results exceed 50 % of the STLC value.	• Measure depth at apparent maximum and minimum accumulation of sediment. Calculate average depth • Sample according to OMM plan and send samples to lab	June 1 each year	Remove and dispose of sediment. Regrade and revegetate if vegetation coverage drops below 70 percent. Revegetate with seed as required by threshold on Nov. 1	None
Inspect for burrowing rodent activity	Ground squirrel holes, vole or gopher mounds	Visual observation	Monthly, for rodent activity with abatement immediately if the activity affects the performance of the BMP otherwise abate annually in September	• Where ground squirrels are active, firmly backfill the burrows to prevent seepage, erosion and leakage.	None

EXTENDED DETENTION BASINS
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
				• Where ground squirrels are not active, confirm that no owl activity is present (a biologist may be needed if uncertain). Firmly backfill the burrows to prevent seepage, erosion and leakage. • Where gophers are present, trap the gophers and level the mounds and firmly backfill the burrows to prevent seepage, erosion and leakage. • Where voles are present, firmly backfill the burrows to prevent seepage, erosion and leakage • If ground squirrel abatement is needed conduct a one time poisoning program. After the appropriate amount of time has passed (determined by the pesticide	

EXTENDED DETENTION BASINS
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
				applicator), firmly backfill the burrows to prevent seepage, erosion and leakage.	
Inspect for possible endangered species, threatened species and species of special concern. within the BMP maintenance perimeter.	Evidence of ponding, emergence of wetland or woody vegetation, shrubs, dwarf plantain, or burrowing animal damage. Presence of logs, woodpiles, rocks, or large debris.	Visual observation	Weekly, during the wet season	• Remove woody vegetation, shrubs, dwarf plantain, pickleweed and woody wetland vegetation[3] in the basin within 10 days. • Remove debris, woodpiles etc. within 10 days. • Correct ponded areas using sand fill • For vulnerable sites, on Mar 1, deploy stakes with mylar strips and place scarecrow device around BMP. • If burrows are found between Mar 1 and Aug 30, a biologist needs to confirm that no birds are nesting in the burrow before sealing the hole.	Vulnerable sites are: I-5/SR56 I-5/Manchester I-15/SR-78

EXTENDED DETENTION BASINS
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
Inspect for standing water	Water accumulation in any structure or other location within the basin	Standing water in any structure or other location within the basin	Annually, May 1	Where gravity draining is possible, drain the standing water	None
General Maintenance Inspection	Inlet structures, outlet structures, side slopes or other features damaged, significant erosion, emergence of trees or woody vegetation, graffiti or vandalism, fence damage, etc.	Visual observation	Monthly	Within 10 working days, take corrective action. Consult engineers if immediate solution is not evident.	None

INFILTRATION BASINS

Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
72 hour infiltration of design volume	Evidence of ponding water after 72 hours	Evaluation of water level within basin using data logging bubbler or visual observation of basin for evidence of ponding water	72 hours after target storm event	Remove sediment, scarify invert and revegetate before November 1. If problem persists, immediately notify engineer. Undertake investigation for course of action to achieve acceptable infiltration rate or other acceptable solution. If unable to achieve acceptable infiltration rate or implement alternative solution then move to decommission	None
Vegetation of basin invert and side slopes	Plant height exceeds 12 inches	Visual observation and random measurements through out the side slope and invert area	Monthly	Cut vegetation to a height of 6 inches and remove cuttings. Target completion period within 30 days.	None
Inspect for possible vector harborage	Standing water for more than 72 hours	Visual observation	Monthly and 72 hours after target storm event	Immediately notify VCD for vector abatement assessment	None
Inspect for standing water	Water accumulation in any structure or other location within the basin	Standing water in any structure or other location within the basin	Annually, May 1	Where gravity draining is possible, drain the standing water	None
Inspection for trash and debris at inlet structures	Debris/trash present	Visual observation	Monthly	Remove and dispose of debris/trash. Target com-pletion period within 10 days.	None

INFILTRATION BASINS

Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
Inspection for sediment management	Sediment accumulation greater than 18-inches or 10 percent of basin volume which ever is less	Measure depth at apparent maximum and minimum accumulation of sediment. Calculate average depth	June 1 each year	Remove, characterize and dispose of sediment. Regrade and revegetate if vegetation coverage drops below 70 percent. Revegetate with seed as required by threshold on Nov. 1	None
Inspection and characterization for sediment removal	Any parameter concentration (See Table 5.2, Vol II) exceeds 50% of Title 22 TTLC. Or, if the parameter concentration falls between 10X STLC and TTLC, is less than 50% TTLC, and the WET results exceed 50 % of the STLC value.	Sample according to OMM plan and send samples to lab	May 1 each year	Remove and dispose of sediment regrade basin floor to ensure proper drainage. Revegetate on November 1 if coverage falls below 70%.	None
Vegetation coverage inspection	Coverage falls below 70 percent	Visual observation	During month of September	Plant during month of November	None
Inspect for burrowing rodent activity	Ground squirrel holes, vole or gopher mounds	Visual observation	Monthly, for rodent activity with abatement immediately if the activity affects the performance of the BMP otherwise abate annually in September	• Where ground squirrels are active, firmly backfill the burrows to prevent seepage, erosion and leakage. • Where ground squirrels are not active, confirm that no owl activity is	None

INFILTRATION BASINS
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
				present (a biologist may be needed if uncertain). Firmly backfill the burrows to prevent seepage, erosion and leakage. • Where gophers are present, trap the gophers and level the mounds and firmly backfill the burrows to prevent seepage, erosion and leakage. • Where voles are present, firmly backfill the burrows to prevent seepage, erosion and leakage • If ground squirrel abatement is needed conduct a one time poisoning program. After the appropriate amount of time has passed (determined by the pesticide applicator), firmly backfill the burrows to prevent seepage, erosion and leakage.	

INFILTRATION BASINS

Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
Inspect for possible endangered species, threatened species and species of special concern within the BMP maintenance perimeter.	Evidence of ponding, emergence of wetland or woody vegetation, shrubs, dwarf plantain, or burrowing animal damage. Presence of logs, woodpiles, rocks, or large debris.	Visual observation	Weekly, during the wet season	• Remove woody vegetation, shrubs, dwarf plantain, pickleweed and woody wetland vegetation[3] in the basin within 10 days. • Remove debris, woodpiles etc. within 10 days. • Correct ponded areas using sand fill. If burrows are found between Mar 1 and Aug 30, a biologist needs to confirm that no birds are nesting in the burrow before sealing the hole.	None
General Maintenance Inspection	Inlet structures, outlet structures, side slopes or other features damaged, significant erosion, emergence of trees or woody vegetation, graffiti or vandalism, fence damage, etc.	Visual observation	Monthly	Within 30 working days, take corrective action. Consult engineer if immediate solution is not evident.	None

INFILTRATION TRENCHES
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
Design infiltration rate	Infiltration rate falls below 90 percent of design rate	Calculate infiltration rate with pressure transducer or measure in observation well	After each target storm	Immediately notify engineer. Undertake investigation for course of action to achieve acceptable infiltration rate. If unable to achieve acceptable infiltration then BMP operations cease.	Carlsbad MS – 1.2 in/hr Altadena MS – 1.5 in/hr
Inspect for possible vector harborage	Standing surface water for more than 72 hours	Visual observation	Monthly and 72 hours after target storm event	Immediately notify VCD for vector abatement assessment	None
Inspection for trash and debris at inlet and outlet structures	Trash/debris present	Visual observation	Monthly	Remove and dispose of trash and debris. Target completion period within 10 days.	None
Inspect for sediment accumulation	Visible sediment	Visual inspection of the stone aggregate, no sediment should be visible at the top of the trench.	Monthly during the dry season After every storm greater than 0.5-inches	Remove top layer of trench, silt, filter fabric and stone, wash stone and reinstall fabric and stone into trench	None

INFILTRATION TRENCHES
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
Inspect for burrowing rodent activity	Ground squirrel holes, vole or gopher mounds	Visual observation	Monthly, for rodent activity with abatement immediately if the activity affects the performance of the BMP otherwise abate annually in September	• Where ground squirrels are active, firmly backfill the burrows to prevent seepage, erosion and leakage. • Where ground squirrels are not active, confirm that no owl activity is present (a biologist may be needed if uncertain). Firmly backfill the burrows to prevent seepage, erosion and leakage. • Where gophers are present, trap the gophers and level the mounds and firmly backfill the burrows to prevent seepage, erosion and leakage. • Where voles are present, firmly backfill the burrows to prevent seepage, erosion and leakage • If ground squirrel	None

INFILTRATION TRENCHES
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
				abatement is needed conduct a one time poisoning program. After the appropriate amount of time has passed (determined by the pesticide applicator), firmly backfill the burrows to prevent seepage, erosion and leakage.	
Inspect for standing water at end of wet season	Spreader ditch contains water following the wet season (i.e., June 1 through September 30)	Visual observation	May 1 each year	Remove spreader ditch bypass plug during first week of dry season to allow water to drain into infiltration trench. Remove bypass drain blockage monthly.	Bypass plug will be installed throughout the wet season
Inspect for accumulation of sediment and debris in biofiltration strip spreader ditch	Spreader ditch contains sediment and debris following the wet season (i.e., June 1 through September 30)	Visual observation	Annually, during the first week of the dry season	Remove collected sediment and debris from the spreader ditch.	None
General Maintenance Inspection	Inlet structures, outlet structures, filter fabric or other features damaged, emergence of trees or woody vegetation, graffiti or vandalism, fence damage, etc.	Visual observation	Monthly	Within 30 working days, take corrective action. Consult engineer if immediate solution is not evident.	None

MEDIA FILTERS – PERLITE/ZEOLITE
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
Design flow rate through canisters: 15 gpm per canister	Less than 13 gpm flow rate per canister, measured collectively on a per vault basis	Evaluate peak and average flow rates drain time from inlet and outlet flow data loggers or staff gage within vaults	During one storm per month during wet season	Within 10 working days or as weather conditions permit, back flush canisters and remove sediment in the vault. If back flushing does not restore flow through rate, replace canisters.	None
Inspect for sediment accumulation in pre-treatment sedimentation chamber	Maximum 12-inches Any parameter concentration (See Vol II) exceeds 50% of Title 22 TTLC. Or, if the parameter concentration falls between 10X STLC and TTLC, is less than 50% TTLC, and the WET results exceed 50 % of the STLC value.	Measure with appropriate device Characterize sediment by sampling according to OMM plan Vol II	Measure sediment depth monthly during period of extended wet weather. Characterize sediment annually on May 1	Remove sediment within 10 days during wet season, characterize sediment and dispose of the sediment within 30 days If sediment characterization exceeds maintenance indicator, remove and dispose of sediment.	
Inspect for minor maintenance	Per manufacture's guidelines	None	Monthly	Flush underdrains and other maintenance per manufacturer's guidelines.	None.
Manufacturer's	Per manufacture's	Per manufacture's	Annually, May 1	Replace canisters,	None

MEDIA FILTERS – PERLITE/ZEOLITE
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
recommended major maintenance	guidelines	guidelines		remove sediment and other maintenance per manufacturer's guidelines	
Inspection for trash and debris at inlet and outlet structures and within vaults	Trash/debris present	Visual observation	Weekly during the wet season and monthly during the dry season	Remove and dispose of trash and debris. Target completion period within 1 day during wet season and 10 days during dry season.	None
Inspect for vector harborage	Standing water for more than 72 hours	Visual Observation	Monthly and 72 hours after target storm event	Immediately notify VCD for vector abatement assessment. Renew vector control briquettes every 3 months.	None
Inspect for standing water	Water accumulation in any structure or other location within the filter	Standing water in any structure or other location within the filter	Annually, May 1	Where gravity draining is possible, drain the standing water	None
General Maintenance Inspection	Inlet structures, outlet structures, vault, piping, or other features damaged and for graffiti or vandalism	Visual observation	Monthly	Within 30 working days, take corrective action. Consult engineer if immediate solution is not evident.	None

MEDIA FILTERS – SAND
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
Design filter loading rate of 0.0545 gpm/sf (10.5 ft/d), or Drain time of 48 hours	Loading rate drops below 9 ft/d or Drain time exceeds 48 hours	Use staff gage in vault to measure loading rate, or Evaluate peak and average loading rates from inlet and outlet flow data loggers or.	During one storm event per month if staff gage is used. After one storm event per month during wet season	Remove sediment, trash and debris., remove top 2 inches of media and dispose of sediment. Restore media depth to 18 inches when overall media depth drops to 12 inches. Target completion period within 10 days. If problem persists, consult with engineer.	None.
Inspect for sediment accumulation in sedimentation chamber	Maximum 12-inches, or Any parameter concentration (See Vol II) exceeds 50% of Title 22 TTLC. Or, if the parameter concentration falls between 10X STLC and TTLC, is less than 50% TTLC, and the WET results exceed 50 % of the STLC value.	Measure with appropriate device Characterize sediment by sampling according to OMM plan Vol II and send samples to lab	Measure sediment depth monthly during period of extended wet weather. Characterize sediment annually on May 1	Remove sediment within 10 days during wet season, characterize sediment and dispose of the sediment within 30 days If sediment characterization exceeds maintenance indicator, remove and dispose of sediment.	

MEDIA FILTERS – SAND
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
Inspect for vector harborage	Standing water for more than 72 hours	Visual observation	Monthly and 72 hours after target storm event	Immediately notify VCD for vector abatement assessment. Renew vector control briquettes every 3 months or as recommended by the VCD	None
Inspection for trash / debris at inlet and outlet structures and on media surface	Trash and debris present	Visual observation	Weekly during the wet season and monthly during the dry season	Remove and dispose of trash and debris. Target completion period within 1 day during wet season and 10 days during dry season.	None
Inspect pumps for proper functioning	Pump does not operate	Energize pump to see if water is discharged	September or after one month of inactivity during the wet season	Make assessment to determine if problem is electrical or mechanical. Take appropriate action. Replace pump if needed. Target completion time is 10 days (keep one pump in storage as back-up)	District 7 filters only
Inspect pumps for serviceability and periodic maintenance	Per manufacture's guidelines	Per manufacture's guidelines	Per manufacture's guidelines	Per manufacture's guidelines	District 7 filters only
Inspect for burrowing rodent activity	Ground squirrel holes, vole or gopher mounds	Visual observation	Monthly, for rodent activity with abatement immediately if the activity affects the performance of the BMP otherwise abate annually	• Where ground squirrels are active, firmly backfill the burrows to prevent seepage, erosion and leakage.	None

MEDIA FILTERS – SAND
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
			in September	• Where ground squirrels are not active, confirm that no owl activity is present (a biologist may be needed if uncertain). Firmly backfill the burrows to prevent seepage, erosion and leakage. • Where gophers are present, trap the gophers and level the mounds and firmly backfill the burrows to prevent seepage, erosion and leakage. • Where voles are present, firmly backfill the burrows to prevent seepage, erosion and leakage • If ground squirrel abatement is needed conduct a one time poisoning program. After the appropriate amount of time has passed (determined	

MEDIA FILTERS – SAND
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
				by the pesticide applicator), firmly backfill the burrows to prevent seepage, erosion and leakage.	
Inspect for possible endangered species, threatened species and species of special concern within the BMP maintenance perimeter.	Presence of bare ground, sparse ground cover, woodpiles, rocks, logs, rocks, evidence of burrowing animal damage or evidence of ponding, emergence of wetland or woody vegetation, shrubs, dwarf plantain,	Visual observation	Weekly, during the wet season	• On March 1 place nylon/plastic mesh with mylar strips over the filter sand area to prevent bird nesting. Remove the mesh and mylar in September each year. If nesting occurs in the BMP, immediately notify the engineer. • Remove debris, woodpiles etc. within 10 days. • On Mar 1, deploy stakes with mylar strips and place scarecrow device around BMP. If burrows are found between Mar 1 and Aug 30, a biologist needs to confirm that no birds are nesting in the burrows before sealing the hole.	Vulnerable sites: I-5/La Costa PR I-5/SR-78 PR

MEDIA FILTERS – SAND
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
				• Remove woody vegetation, shrubs, dwarf plantain, pickleweed and woody wetland vegetation[3] outside the wetted pond area within 10 days.	
Inspect for standing water	Water accumulation in any structure or other location within the filter	Standing water in any structure or other location within the filter	Annually, May 1	Where gravity draining is possible, drain the standing water	None
General Maintenance Inspection	Inlet structures, outlet structures, filter fabric or other features damaged, emergence of vegetation, graffiti or vandalism, fence damage, etc.	Visual observation	Monthly	Within 30 working days, take corrective action. Consult engineer if immediate solution is not evident.	None

MULTI-CHAMBER TREATMENT TRAINS
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
Maximum filter drain time of 72 hrs for design and smaller storms	Drain time greater than 72 hours	Visual observation	After each target storm	If filter surface has sediment, remove and replace filter fabric blanket. Target completion period within 10 days. If problem persists, consult with engineer, the media may need to be replaced.	None
Inspection for trash/ debris at inlet and outlet structures and the MCTT	Trash/debris present	Visual observation	Weekly during the wet season and monthly during the dry season	Remove and dispose of trash and debris. Target completion period within 1 day during wet season, 10 days during dry season..	None
Inspection for sediment accumulation	Maximum of 6-inches in main settling chamber Maximum of 2-feet grit chamber, or Any parameter concentration (See Vol II) exceeds 50% of Title 22 TTLC. Or, if the parameter concentration falls between 10X STLC and TTLC, is less than 50% TTLC, and the	Measure with appropriate device Characterize sediment by sampling according to OMM plan Vol II and send samples to lab	Measure sediment depth monthly during period of extended wet weather. Characterize sediment annually on May 1	Remove sediment within 10 days during wet season, characterize sediment and dispose of the sediment within 30 days If sediment characterization exceeds maintenance indicator, remove and dispose of sediment.	None

MULTI-CHAMBER TREATMENT TRAINS
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
	WET results exceed 50 % of the STLC value.				
Inspect for possible vector harborage	Standing water for more than 72 hours	Visual observation	Monthly and 72 hours after target storm event	Immediately notify VCD for vector abatement assessment. Renew vector control briquettes every 3 months.	None
Inspect for standing water	Water accumulation in any structure or other location within the device	Standing water in any structure or other location within the device	Annually, May 1	Where gravity draining is possible, drain the standing water	None
Replace filter media every 3 years per designer's specification	Operation greater than 3 years	Not applicable	Every 3 years	Remove and replace filter media	None
Renew sorbent pillows in main settling chamber every year per designer's specification	Not applicable	Not applicable	Annually at the end of the wet season	Renew sorbent pillows	None
Inspect pumps for proper functioning	Pump does not operate	Energize pump to see if water is discharged	September or after one month of inactivity during the wet season	Make assessment to determine if problem is electrical or mechanical. Take appropriate action. Replace pump if needed. Target completion time s 10 days (keep one pump in storage as back-up)	None
Inspect pumps for serviceability and periodic maintenance	Per manufacture's guidelines	Per manufacture's guidelines	Per manufacture's guidelines	Per manufacture's guidelines	None

MULTI-CHAMBER TREATMENT TRAINS
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
General Maintenance Inspection	Inlet structures, outlet structures, filter fabric, settling tubes or other features damaged, emergence of vegetation, graffiti or vandalism, fence damage, etc.	Visual observation	Monthly	Within 30 working days, take corrective action. Consult engineer if immediate solution is not evident.	None

OIL-WATER SEPARATOR
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
Inspect for sediment accumulation in the pre-separator and separator chamber	Greater than 12-inches	Measure with appropriate device	Monthly	Within 10 working days remove the accumulated material with a suction hose from a vacuum vehicle or portable pump.	None
Inspect for oil accumulation in oil chamber	Oil depth is not more than 50 percent of chamber volume	Gauge the level of oil/water with a wooden gauge stick	Monthly	Within 10 working days remove and dispose of oil and grease.	None
Inspect coalescer for debris and gummy deposits	Debris or gummy deposits present	Visual observation	Two times per year – at the beginning and end of each wet season (Sep 1 and April 15)	Wash the coalescer with a high-pressure hot water.	None
Inspect water level in tank	Less than full	Visual observation	Monthly	Fill with water within 1 day	None
Inspect for general mechanical integrity	Per manufacture's guidelines	Per manufacture's guidelines	Monthly during the wet season and before the beginning of the wet season	Operate each mechanical component to ensure proper operation. Repair as needed	None

WET BASIN
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
24 hour draw down measured between the outlet structure and invert of the WQ orifice in the outlet structure..	Drawdown greater than 25 hours or water is flowing over weir.	Evaluate drain time from inlet and outlet flow data loggers or observe 25 hours after target storm. Observation of water flowing over spillway	After each target storm event	If >25-hours: Open gate to discharge water to permanent pool elevation, clear outlet of debris. Consult engineer if needed. If water is spilling over weir open canal gate until water level is at permanent pool elevation.	None
Inspect for burrowing rodent activity	Ground squirrel holes, vole or gopher mounds	Visual observation	Monthly, for rodent activity with abatement immediately if the activity affects the performance of the BMP otherwise abate annually in September	• Where ground squirrels are active, firmly backfill the burrows to prevent seepage, erosion and leakage. • Where ground squirrels are not active, confirm that no owl activity is present (a biologist may be needed if uncertain). Firmly backfill the burrows to prevent seepage, erosion and leakage. • Where gophers are present, trap the	None

WET BASIN
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
				gophers and level the mounds and firmly backfill the burrows to prevent seepage, erosion and leakage. • Where voles are present, firmly backfill the burrows to prevent seepage, erosion and leakage • If ground squirrel abatement is needed conduct a one time poisoning program. After the appropriate amount of time has passed (determined by the pesticide applicator), firmly backfill the burrows to prevent seepage, erosion and leakage.	
Inspect for possible endangered species, threatened species and species of special concern within the BMP maintenance perimeter.	Evidence of emergence of woody vegetation, shrubs, dwarf plantain, or wetland vegetation, burrowing animal damage. Presence of logs, woodpiles, rocks, or large debris.	Visual observation	Weekly, during the wet season	• Remove woody vegetation, shrubs, dwarf plantain, pickleweed and woody wetland vegetation[3] above the maintenance road area within 10 days.	None

WET BASIN
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
				• Remove debris, woodpiles etc. within 10 days. • On Mar 1, deploy stakes with mylar strips and place scarecrow device around BMP. If burrows are found between Mar 1 and Aug 30, a biologist needs to confirm that no birds are nesting in the burrows before sealing the hole. Remove floating debris and dead and floating vegetation mats within 10 days. •Maintain wetland vegetation only between August and February	
General Maintenance Inspection	Inlet structures, outlet structures, side slopes or other features damaged, significant erosion, graffiti or vandalism, fence damage, etc.	Visual observation	Monthly	Within 10 working days, take corrective action. Consult engineers is immediate solution is not evident.	None
Inspect zone of periodic inundation vegetation	•Wetland plant density in the zone of periodic	Visual observation/estimate	Annually, approx. May 1	By Nov 1 each year, restore to "as	None

WET BASIN
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
	inundation is maintained at the "as constructed" density.			constructed" plant density	
Inspect for sediment accumulation in forebay and main pond	More than 2 inches in the forebay and 4 inches in the main pond, or	Measure with appropriate device	Monthly	Remove and dispose of sediment. Target completion period within 30 days. If vegetation coverage drops below 30 percent during maintenance operation, replant vegetation on November 1 to restore to 30 percent coverage	La Costa site only
	Any parameter concentration (See Vol II) exceeds 50% of Title 22 TTLC. Or, if the parameter concentration falls between 10X STLC and TTLC, is less than 50% TTLC, and the WET results exceed 50 % of the STLC value.	Sample according to OMM plan Vol II and send samples to lab	May 1 each year	If sediment characterization exceeds maintenance indicator, remove and dispose of sediment. Regrade. Revegetate, if vegetation coverage drops below 30 percent. Replant vegetation on November 1 to restore to 30 percent coverage	

CONTINUOUS DEFLECTIVE SEPARATION (CDS) UNITS

Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
Inspect for accumulation of trash and debris	Unit 85 percent full	Visual observation	Monthly during the wet season	Empty unit when the it is 85 percent full or annually in May, effect cleaning within 30 days	
Inspect for vector harborage	Standing water for more than 72 hours	Visual observation	Monthly and 72 hours after target storm event	Immediately notify VCD for vector abatement assessment.	None
Inspect the screen for damage and to ensure that it is properly fastened.	Screen becomes clogged, damaged or loose	Visual observation	Annually between September 15 and October 1)	Brush or high pressure wash the screen	None
Inspection for structural integrity	Holes in screen, large debris, damage to housing or weir box	Visual observation	Monthly or prior to a target storm during the wet season, and annually in May	Immediately consult with engineer and manufacturer's representative to develop a course of action, effect repairs within 10 working days	None

Notes for all BMPs:

1. Design storm event is a storm that is a one year 24 hour recurrence frequency.
2. A target storm event is a storm with a predicted greater than 0.25 inches of rainfall or 0.1 inches for drain inlet inserts. Storm events should be separated by at least 72 hours of dry weather from the previous storm event.
3. Woody wetland vegetation consists of: willows *(Salix spp)*, mule fat *(baccharis salicifolia)*, cottonwood *(populus fremontii)*, western sycamore *(plantanus racemosa)* and emergent large stature monocots including the genera *Cyperus, Juncus, Scirpus, and Typha)*

This Maintenance Indicator Document has been developed using site-specific information gathered by specialists trained in the identification of threatened and endangered species and their habitat. Information contained in this document includes guidance for inspection for possible threatened and endangered species harborage. Further, some of the maintenance recommendations are based on the requirements of specific plant species used in this Pilot Program. The recommendations provided in this document must be reassessed with respect to species and plant materials if the guidance contained herein is to be used for a separate project in another area.

Appendix C-1

California Health and Safety Code, Division 3. Pest Abatement Mosquito Abatement Districts or Vector Control Districts

CALIFORNIA HEALTH AND SAFETY CODE

DIVISION 3. PEST ABATEMENT

CHAPTER 5. MOSQUITO ABATEMENT DISTRICTS OR VECTOR CONTROL DISTRICTS

Article 1. General Provisions

Article 2. Formation

Article 3. Officers

Article 3. Officers [continued]

Article 4. District Powers

CHAPTER 1. DEFINITIONS [continued]

CHAPTER 2. POWERS AND DUTIES

Article 1. Vector Biology and Control

Section

Article 2. Importation of Exotic Vectors

Section

Article 3. Rodent Abatement

Section

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Appendix C-2

California Health and Safety Code
Seciton 2270-2294

CALIFORNIA CODES
HEALTH AND SAFETY CODE
SECTION 2270-2294

2270. The district board may do all of the following:

(a) Take all necessary or proper steps for the control of mosquitoes, flies, or other vectors, either in the district or in territory not in the district but so situated with respect to the district that mosquitoes, flies, or other vectors may disperse from the territory into the district.

(b) Abate as nuisances all standing water and other breeding places for mosquitoes, flies, or other vectors, either in the district or in territory not in the district but so situated with respect to the district that mosquitoes, flies, or other vectors from the territory disperse into the district.

(c) Purchase the supplies and materials, employ the personnel and contract for the services which may be necessary or proper in furtherance of the objects of this chapter.

(d) If necessary or proper in the furtherance of the objects of this chapter, build, construct, repair, and maintain the necessary dikes, levees, cuts, canals, or ditches upon any land and acquire by purchase, condemnation, or by other lawful means, in the name of the district, any lands, rights-of-way, easements, property, or material necessary for any of those purposes.

(e) Make contracts to indemnify or compensate any owner of land or other property for any injury or damage necessarily caused by the use or taking of property for dikes, levees, cuts, canals, or ditches.

(f) Enter upon any property without hinderance or notice, either within the district or so reasonably adjacent thereto that vectors may disperse into the district, for any of the following purposes:

(1) To inspect to ascertain the presence of vectors or their breeding places.

(2) To abate public nuisances in accordance with this article, either directly or by giving notice to the property owner to abate a nuisance.

(3) To ascertain if a notice to abate vectors has been complied with.

(4) To treat property with appropriate physical, chemical, or biological control measures.

(g) Sell or lease any service, land, rights-of-way, easements, property or material acquired by the district. Equivalent properties may be exchanged, if it is in the best interests of the district to do so.

(h) Borrow money in any fiscal year and repay it in the same or in the next ensuing fiscal year. The amount borrowed in any fiscal year shall not exceed fifteen cents ($0.15) on each one hundred dollars ($100) of assessed valuation of property in the district.

(i) Issue warrants payable at the time stated in the warrant to evidence the obligation to repay money borrowed or any other obligation incurred by the district. Warrants so issued shall draw interest at a rate fixed by the board not to exceed 5 percent per year, payable annually or semiannually as the board may prescribe.

(j) Provide a civil service system for any or all employees of the district.

(k) Assess civil penalties, as determined in the discretion of the board, but not to exceed five hundred dollars ($500) per day for each day that a notice or hearing order to abate a nuisance has not been complied with.

Any sum which may be collected shall become part of the district's general fund to be used solely for vector control purposes.

(l) Levy, by resolution or ordinance, a service charge against any or all parcels of land within the district to pay for the cost of vector surveillance and control. The schedule of charges shall be made, reviewed, and adopted annually after notice and hearing in connection with the schedule. Following the hearing, the board may classify parcels of property according to their use in relation to the cost of vector surveillance and control. The board may bill for the charges annually or more frequently. The charges shall be collected and paid by the county in the same manner as property taxes by the county. The service charge shall be reasonably related to the district's cost for providing vector surveillance and control and shall not be deemed a tax of any kind. Any sum collected shall be used solely for purposes of vector surveillance and control.

(m) Set the tax or assessment rates which are necessary to carry out the purposes of this article.

(n) Do any and all things necessary for, or incident to, the powers granted by, and to carry out the objects specified in, this chapter.

2272. Except as otherwise provided in Section 2272.5, a public nuisance may be abated in any action or proceeding by any remedy provided by this chapter or any other provision of law.

2272.5. Section 2272 shall not apply to a public nuisance which exists at an agricultural operation by reason of excessive domestic fly larval development and excessive adult fly emergence as defined in subparagraph (C) of paragraph (1) of subdivision (e) of Section 2200. An agricultural nuisance described in this section may be abated in any action or proceeding only by the remedies provided by this chapter. This chapter shall provide the exclusive source of costs and civil penalties which may be assessed by reason of the agricultural nuisance against the owner or operator of an agricultural operation at which the nuisance is found to exist.

2273. The procedures for abatement of nuisances and assessment of the cost thereof as a lien against properties, as provided for pest abatement districts in Chapter 8 (commencing with Section 2800) of this division, may be utilized by the district board as an alternative to the abatement procedures set forth in this chapter.

2274. Whenever a nuisance specified in this chapter exists upon any property, either in the district or in territory not in the district but so situated with respect to the district that mosquitoes, flies, or other vectors from the territory disperse into the district, the district board may notify in writing the owner or party in possession, or the agent of either, of the existence of the nuisance.

2275. The notice shall do all of the following:

(a) State the finding of the district that a public nuisance exists on the property and the location of the nuisance on the property.

(b) Direct the owner or party in possession to take appropriate steps to eliminate, or prevent the recurrence of, the nuisance.

(c) Inform the owner or party in possession that failure to comply with the requirements of subdivision (b) shall subject the owner or party in possession to civil penalties of not more than five hundred dollars ($500) per day for each day the nuisance continues after the time specified for the abatement of the nuisance in the notice.

(d) Inform the owner or party in possession that before complying with the requirements of the notice, the owner or party in possession may appear at a hearing before the district board at a time and place stated in the notice.

2277. The notice shall be served upon the owner of record, or person having charge or possession, of the property upon which the nuisance exists, or upon the agent of either.

2278. The notice may be served by any person authorized by the district board in the same manner as a summons in a civil action, or it may be served by registered mail or by personal delivery with proof of service.

2279. If the property belongs to a person who is not a resident of the district, and is not in charge or possession of any person, and there is no tenant or agent of the owner upon whom service can be made, who can after diligent search be found; or if the owner of the property can not after diligent search be found, the notice may be served by posting a copy in a conspicuous place upon the property for a period of ten days, and by mailing a copy to the owner addressed to his address as given on the last completed assessment roll of the county in which the property is situated, or, in the absence of an address on the roll, to his last known address.

2280. Before complying with the requirements of the notice the owner or party in possession may appear at a hearing before the board at a time and place fixed by the board and stated in the notice. At the hearing the district board shall determine whether the initial finding as set forth in the notice is correct and shall permit the owner or party in possession to present testimony in his behalf. If, after hearing all the facts, the board makes a determination that a nuisance exists on the property, the board shall order compliance with the requirements of the notice or with alternate instructions issued by the board.

Any failure to comply with any order of the board issued pursuant to this section shall subject the owner or party in possession to civil penalties as determined by the discretion of the board which shall not exceed five hundred dollars ($500) per day for each day such order is not complied with.

2280.1. Any judicial review of administrative procedure provided for in this chapter shall be pursuant to Section 1094.5 of the Code of Civil Procedure.

2281. Any recurrence of the nuisance may be deemed to be a continuation of the original nuisance.

2282. In the event that the nuisance is not abated within the time specified in the notice or at the hearing, the district board may abate the nuisance by destroying the larvae or pupae and by taking appropriate measures to prevent the recurrence of further breeding.

2285. Notice of the lien, particularly identifying the property on which the nuisance was abated and the amount of such lien, and naming the owner of record of such property, shall be recorded by the district board in the office of the county recorder of the county in which the property is situated within one year after the first item of expenditure by the board or within 90 days after the completion of the work, whichever first occurs. Upon such recordation, such lien shall have the same force, effect and priority as if it had been a judgment lien imposed upon real property which was not exempt from execution, except that it shall attach only to the property described in such notice, and shall continue for 10 years from the time of the recording of such notice unless sooner released or otherwise discharged.

2285.5. The district board may at any time release all or any portion of the property subject to a lien imposed pursuant to Sections 2284 and 2285 from the lien or subordinate such a lien to other liens and encumbrances if it determines that the amount owed is sufficiently secured by a lien on other property or that the release or subordination of such lien will not jeopardize the collection of such amount owed. A certificate by the board, or its designee, to the effect that any property has been released from such lien or that such lien has been subordinated to other liens and encumbrances shall be conclusive evidence that the property has been released or that the lien has been subordinated as provided in such certificate.

2286. An action to foreclose the lien shall be commenced within six months after the filing and recording of the notice of lien.

2287. The action shall be brought by the district board in the name of the district.

2288. When the property is sold, enough of the proceeds to satisfy the lien and the costs of foreclosure shall be paid to the district; and the surplus, if any, shall be paid to the owner of the property if known, and if not known, shall be paid into the court in which the lien was foreclosed for the use of the owner when ascertained.

2289. The lien provisions of this chapter do not apply to the property of any county, city, district, or other public corporation. However, the governing body of the county, city, district, or other public corporation shall repay to any district the amount expended by the district upon any of its property under this chapter upon presentation by the district board of a verified claim or bill.

2290. Any district organized on or after August 14, 1931, and any such district organized prior to that date that elects to do so by a vote taken at an election called and conducted as provided for an election for a tax to raise additional funds for the district, may provide for the destruction and extermination of rats in the district; and may include suitable sums for that purpose in its expense estimates, which shall be raised in the manner provided by law for the raising of other sums for the district.

The district board shall supervise and manage the destruction and extermination of rats in the district by the officers, agents, and employees of the district.

2290.5. Any district may also abate as a nuisance any infestation of rats either by court proceeding or by administrative action and may collect the costs thereof in the same manner provided for the abatement of breeding places for mosquitoes, flies, and other insects.

2291. Any district may conduct vector surveillance and control projects for any part of the district.

2291.1. The district board shall determine which of the projects authorized by Section 2291 shall be carried out and shall determine, as to each project, that it is one of the following:
(a) For the common benefit of the district as a whole.
(b) For the benefit of two or more zones, which may be referred to as participating zones.
(c) For the benefit of a single zone.

2291.2. (a) (1) The district board may institute projects for one or more zones, for the financing and execution of vector surveillance and control projects of common benefit to the zone or zones.
(2) Before beginning a project, the district board shall adopt a resolution which shall specify its intention to undertake the project, estimate the cost to be borne by the zones, state the duration of the assessment, state the general objectives of the surveillance or control project, and fix a time and place for a public hearing and a public meeting on the project. In the case of more than one zone, the resolution shall specify the proportionate cost to be borne by each of the zones.
(3) Notice of the public meeting and the public hearing shall be given pursuant to Section 54954.6 of the Government Code.
(b) At any time before the time set for the hearing, any owner of any property which is proposed to be assessed may make written protest against the proposed project and assessment. The written protest shall contain a description of the property sufficient to identify the property. If the signer is not shown on the last equalized assessment roll as the owner of that property, the written protest shall contain written evidence that the signer is an owner of the property proposed to be assessed.
(c) At the time and place stated in the notice for the public meeting and the public hearing, the district board shall hear and consider any objections and protests to the proposed project and assessments.
The district board may continue the public meeting and the public hearing from time to time. Any written protest may be withdrawn in writing by the person making the protest at any time before the conclusion of the hearing.
(d) Following the conclusion of the hearing, if the district board finds that the written protests filed and not withdrawn represent 50 percent or more of the total amount of expected revenue from the proposed assessment, the board shall abandon the proposed project and assessment. If the district board finds that the written protests filed and not withdrawn represent less than 50 percent of the total amount of expected revenue from the proposed assessment, the district board may, at its discretion, proceed with or abandon the proposed project and assessment.
(e) The assessments levied pursuant to this section shall be collected at the same time and in the same manner as county taxes.
The county may deduct its actual costs incurred for collecting the assessments before remitting the balance to the district. The assessments shall be a lien on all the property benefited thereby.

Liens for the assessments shall be of the same force and effect as liens for taxes, and their collection may be enforced by the same means as provided for the enforcement of liens for county taxes.

(f) For the purposes of an assessment levied under this section, the property so assessed within a given zone is equally benefited.

2291.3. The provisions of Section 2291.2 shall be exclusive in determining the proper procedure for the institution of projects under Sections 2291, 2291.1, and 2291.2, any other provision of law notwithstanding.

2291.4. In addition to the powers enumerated in Article 5 (commencing with Section 2300), the board may do any of the following:

(a) Levy taxes or assessments in each or any of the zones and participating zones to pay the cost and expenses of carrying out the projects within, or on behalf of, the respective zones, according to the benefits derived or to be derived by the respective zones, by a levy or assessment upon any or all property within a zone or participating zone, including land, improvements, and personal property.

It is declared that for the purposes of any tax or assessment levied under this subdivision, the property so taxed or assessed within a given zone is equally benefited.

(b) Levy taxes or assessments by the method authorized by subdivision (a) in each or any of the zones, according to the special benefits derived or to be derived by the specific properties therein, to pay the cost and expenses of carrying out any of the projects within or on behalf of the respective zone or zones.

2291.5. Any ordinance or resolution adopted by a district prior to January 1, 1987, pursuant to subdivision(l) of Section 2270 which levies an assessment which otherwise meets the requirements of Section 2291.2, shall be deemed to satisfy the requirements of Section 2291.2 and shall continue to be levied and collected notwithstanding the amendment to subdivision(l) of Section 2270 by the chapter of the Statutes of 1986 which added this section.

2291.7. In Lake County, any mosquito abatement district, as authorized by the district board, may, notwithstanding Section 2291.3, conduct or contract for algae research projects and algae control or abatement projects for any part of the district. In undertaking these projects, the district board shall comply with the procedures set forth in subdivisions (a), (b), (c), and (d) in order to levy a benefit assessment for these projects.

(a) Prior to levying any benefit assessment, the board shall comply with all of the following:

(1) The board shall adopt a resolution which shall specify its intention to undertake the project. The resolution shall include all of the following:

(A) A description of the plan, including, but not limited to, all of the following:

(i) The causes of the algae.

(ii) Alternative methods and associated costs of algae prevention, reduction, and control.

(iii) Mitigation measures, including mitigation of the effects of potential treatment on humans, and on fish and wildlife habitat.

(iv) The agency or agencies with responsibilities for algae prevention, reduction, and control. The plan may reference the environmental document prepared pursuant to Division 13 (commencing with Section 21000) of the Public Resources Code.

(B) The establishment of a benefit assessment zone or zones.
(C) A description of the properties to be assessed.
(D) A description of the cost of each assessment.
(E) A statement specifying the duration of the assessment.
(2) The board shall hold public hearings after notice has been published for three successive weeks in a newspaper of general circulation published in the county seat.
(3) The board shall send notice of the resolution and of the hearings to those owners of property to be assessed at least 14 days prior to the public hearing.
(4) After the public hearing, the plan shall be approved by a majority of the owners of property to be assessed. The board shall take no action to implement the plan or the assessment until after the plan is approved by a majority of owners of property to be assessed.
(b) Any herbicide application for the purpose of algae abatement pursuant to this section shall be subject to the approval of the Department of Fish and Game. The department shall grant approval unless it is determined that the application would cause significant diminishment of green or yellow-green algae or zooplankton.
(c) The assessments levied pursuant to this section shall be collected at the same time, and in the same manner, as county taxes. The county may deduct its actual costs incurred for collecting the assessments before remitting the balance to the district. The assessments shall be a lien on all the property benefited thereby. Liens for the assessments shall be of the same force and effect as liens for taxes, and their collection may be enforced by the same means as for the enforcement of liens for county taxes.
(d) For the purposes of an assessment levied under this section, all properties so assessed within a given zone are equally benefited.

The requirements set forth in this section shall only apply to algae research projects and algae control or abatement projects in Lake County.
In enacting this section, the Legislature does not intend to amend the power of any other district to use any other power authorized by this chapter.

2292. Any person who restrains, hinders, obstructs, or threatens any officer or employee of a district in the performance of that person's duties, or any person who interferes with any work done by, or under the direction of, the district is guilty of a misdemeanor.

2294. In case of dispute between government agencies on the need, or the methods and materials used, to abate or prevent a public health nuisance under this chapter, the matter shall be subject to appeal to the State Director of Health Services within 10 days. The director shall take testimony on the issue, and shall decide the matter on appeal and convey his or her decision to the parties within 30 days of the receipt of the appeal. The decision of the director shall be final and conclusive.

Appendix C-3

C3.0-1. Methods of Mosquito and Midge Monitoring

C3.0-2 Major Chemical Vector Control Methods

C-3.0-1 Methods of Mosquito and Midge Monitoring

As discussed in Section 3.0, mosquito and midge monitoring involves adult sampling and larval sampling. Included here is a detailed discussion of equipment and its use in monitoring these vectors.

USE OF TRAPS IN ADULT SAMPLING

CO_2-Light Traps:

Carbon dioxide-light traps will be run for one night each week at each BMP location from April until October, and for one night biweekly from November through March. This sampling frequency coincides with the activity of mosquitoes in Southern California. Multiple traps are recommended for BMP sites that are larger than 0.25 km in diameter. Each trap should carry a site-specific label. The air-actuated gate and the fan of each CO_2-light trap should be programmed to turn on at dusk (30 minutes before civil sunset) and to turn off after sunrise (30 minutes after civil sunrise). In order to attract both mosquitoes and midges, the trap will be equipped with a single 4-watt ultraviolet lamp (wavelength range: 320-420 nm). Each CO_2-light trap should be stocked with 2 kg of solid carbon dioxide (dry ice). During the night, the carbon dioxide will sublimate and be released by the manifold directly above the fan and collection bag at approximately 500ml/min.

The trap is powered by 6-volt batteries. They can also be powered by D-cell alkaline batteries connected in series or by rechargeable 6-volt dry cells. Because of the ultraviolet light, the life of the power supply must exceed 10 amp hours.

If mosquitoes or midges are collected, then the catch will be labeled with a site-specific tag, placed into an insulated cooler, and returned to the laboratory. Prior to identification, the mosquitoes should be killed by freezing or by exposure to carbon dioxide in an enclosed container (e.g., a small insulated chest).

Placement of the CO_2-Light Trap: The CO_2-light trap should be placed in a sheltered position such as near a tree, vegetation, or a vertical wall. If a vertical structure is not present, then the trap can be hung from a stake. The same site should be used to standardize sampling .

Vandalism and theft are common problems encountered during trapping studies. Some of the BMP sites are accessible to the general public. Attempts should be made to hide the traps. Interlacing a metal cable among the parts of a trap and locking it to a vertical structure may provide additional security.

In order to reduce the likelihood of distracting drivers, traps should not be placed adjacent to traffic or breakdown lanes. When possible, light traps should be hidden from traffic.

For the majority of BMP sites, one trap is adequate to census the mosquito/midge populations. If the traps are adequately maintained, trap failure is rare.

Gravid Traps:

One gravid trap should be run for one night each week at each BMP location from April until October, and for one night biweekly from November through March.

Each week a fresh infusion of oviposition medium should be set up in large plastic trash bins. A trash bin should be perforated on the bottom and sides, and set in a second bin prior to adding the infusion constituents. The infusion is composed of 0.5 kg hay, 5 g dried brewer's yeast, 5 g lactalbumen, and 114 liters of water. Water aged for a minimum of seven days is preferred to distilled/deionized water or tap water. The mixture is covered for 5 days outdoors. The water temperature must be kept below 40^{o}C. Prior to use, the infusion should be screened (screen size opening approximately 0.6 cm) to remove floating debris. The infusion should be transported to the BMP sites in 20 liter covered carboys. At each BMP site, four liters of infusion are added to the bottom of the gravid trap and then the top components of the trap are assembled and placed onto the trap's base. The motor/fan of the gravid trap at each BMP location is programmed to activate at dusk (30 minutes before civil sunset). The motors are turned off the following morning when the trap is retrieved.

If mosquitoes are collected, then the catch will be labeled with a site-specific tag, placed into an insulated cooler, and returned to the laboratory. Prior to identification, the mosquitoes will be killed by freezing.

Placement of Traps: The gravid trap and CO_2-light trap can be placed in proximity since they sample different components of adult mosquito population. Because gravid traps contain liquid, a reasonably level site should be selected.

METHODS AND CONSIDERATIONS IN LARVAL SAMPLING

Several factors should be considered when collecting samples of mosquito larvae.

- Approach cautiously in order to avoid disturbing mosquito larvae at the water surface.
- Mosquito larvae are typically associated with vegetation or debris on the water surface. In larger water bodies, larvae will be found in the vegetation at the periphery and not in open, deep water. If conditions are windy, larvae will be concentrated along the windward side of the habitat.
- If it is raining, postpone larval sampling until after the rain.

A standard plastic dipper holds approximately 400 ml of liquid. The sampling method should minimize overflow from the dipper and avoidance behavior by mosquito larvae. The technique that is used depends on: i) the mosquitoes likely to be present, ii) habitat, and iii) weather conditions. A quick dipping technique utilizes a swift and steady flick of the wrist, and works best where emergent vegetation is present and for larvae that are not always at the water surface or that exhibit rapid avoidance behaviors to physical disturbance such *Aedes* and some *Culex.* A slow dipping technique utilizes a slow pulling of the dipper through the water column, and works best for surface-dwelling larvae such as *Anopheles*.

For shallow water (water depth < the height of the dipper's cup), the dipper is held at a 45^{o} angle, and water is allowed to flow into the dipper (Knight 1964,O'Malley 1995).

Three to five dips should be taken every 3-6 m (5-10 paces) around the perimeter of vegetated habitat. Dippers with extendable handles should extend the distance that samples can be taken without creating shadows on the surface of the water.

Larvae can be counted in the field or preserved for enumeration and identification in the laboratory. The water volume of the sample is reduced by filtering the sample through a screen (mesh opening < 200 μm). A concentrator can be constructed from a plastic measuring cup (volume = 500 ml) into which screen windows have been cut. A squirt bottle containing water can be used to rinse any material caught on the screens. The material in the concentrator cup should be rinsed into a labeled sample jar or vial and then preserved with 95% ethanol (final concentration approximately 50% ethanol).

Net Hauls: Mosquito larvae in steep-sided chambers such as catch basins are best sampled by net (Service 1993) or by strainers attached to lines (Siegel and Novak 1997). Three samples, two along the sides of the chamber and one at the center of the basin are recommended. If one side of the catch basin is shaded, then one sample should be taken along the shaded side of the basin. Three plankton or World Health Organization (WHO)-style nets may be lowered into the basin at the same time. Lowering the net(s) into the water will disturb the mosquito larvae, causing them to submerge. After waiting 3-4 minutes, raise the net slowly until the net is within approximately 15 cm (6 inches) of the water surface and then pull the net through the water surface in one rapid motion. A squirt bottle with water can be used to rinse any material caught on the net into the collection chamber at the base of the net. The material in the collection chamber should be rinsed into a labeled sample jar or vial and then preserved with 95% ethanol (final concentration approximately 50% ethanol).

C3.0-2 Major Chemical Vector Control Methods

In southern California, three types of pesticides are currently used against mosquito larvae: mosquitocidal oils, mosquito-specific bacteria and insect growth regulators (IRS). These include mosquitocidal oils, mosquito-specific bacteria, and insect growth regulators.

MOSQUITOCIDAL OILS

Mosquitocidal oil kills mosquito larvae and pupae by suffocation. This oil is the only material available for use in California that is effective against mosquito pupae (Beehler and Mulla 1996). The oils dissipate within 48 hours after application. If this is the only pesticide used, sites where mosquitoes are breeding must be monitored and treated every 7 - 10 days. Mosquitocidal oils are used when pupae are present, or when the condition of the water makes all other pesticides ineffective.

MOSQUITO-SPECIFIC BACTERIA

Bacillus thuringiensis variety *israelensis (Bti)* and *Bacillus sphaericus* are currently registered for use in California. *Bacillus sphaericus* is more effective in wastewater with high organic content and/or suspended sediment than *Bti*.

Both *Bti.* and *B. sphaericus* do not harm humans and non-target organisms when applied according to the label. The toxins they produce degrade rapidly in aquatic environments. The application of *Bti.* and *B. sphaericus* to BMPs should not compromise the water quality.

Sites should be monitored weekly during the peak mosquito season (April until November). *Bti* may provide effective control for 1 to 2 weeks (Mulla 1985). *B. sphaericus* is effective for much longer (weeks to months in small containers, but will have to be applied more frequently at BMPs.

INSECT GROWTH REGULATORS

Methoprene is a synthetic hormone that inhibits the emergence of adult mosquitoes. When applied to sites where larvae are present, mosquitoes fail to develop into adults. Methoprene is available in several formulations including liquid concentrates, pellets, and briquettes, and can also be applied in combination with *Bti.*

Liquid formulations of methoprene are used regularly as part of an integrated control program against mosquitoes in Los Angeles County. Other formulations may also be effective at BMPs. Briquettes release methoprene over a 30-120 day period. Environmental conditions influence the persistence of methoprene, e.g., heavy rainfall, burial by sediment, and thick vegetation inhibit dispersion. Briquettes are used at rates from 0.5 per 100 square feet to 4 per 100 square feet for shallow and low-flow habitats. Application rates vary with the flow-through rates of a site. In general, 1 briquette is

applied per 10 cubic feet (75 gallons) of water at flow rates greater than 40 cubic feet per month. The number of briquettes increases with the maximum water volume in the application site and each four-fold increase in flow rate. When the flow rate exceeds four volume changes per month, the treatment interval is adjusted according to the formula:

[allowable flow/actual flow] x 30 = adjusted interval (days),

where

allowable flow is four volume changes of the maximum volume of the application site.

Methoprene briquettes can control mosquitoes for most of the mosquito season if the conditions at the site are right. Sites where methoprene is applied must be monitored to assess the effectiveness of the application.

Appendix D-1

Caltrans Code of Safe Operating Practices

MAINTENANCE CODE OF SAFE OPERATING PRACTICES

GENERAL OPERATING PROCEDURES

Applicable During All Maintenance Activities

These GENERAL OPERATING PROCEDURES shall be posted on all crew bulletin boards; it should be read and continuously followed by all employees. The Manual containing the individual work activity codes shall be in the crew's quarters, available to all employees.

I. RESPONSIBILITY

A. Before beginnning new planned activities, applicable safe operating procedures and safe equipment usage procedures as given in the *MAINTENANCE CODE OF SAFE PRACTICES MANUAL*, herin referred to as the COSP, shall be reviewed. The purpose of this review is to assure that safe practices are discussed, understood and followed.

B. Supervisors are responsible to see that employees observe and obey all applicable safe practice rules, laws, policies or procedures necessary for the safe conduct of the work, and the supervisor shall take corrective action if necessary to obtain compliance.

C. Each employee shall comply with all the safe practice rules of the COSP and any other safety laws, rules, policies, or procedures applicable to the work being done.

D. Each employee shall be provided with and shall wear required personal protective equipment (PPE) The standard minimum PPE includes hard hat, eye protection, orange vests, and reflective vests at night. Such equipment shall be worn when required by the *MAINTENANCE COSP*, Departmental Policy, Safety Orders, District Instructions or when, in the judgment of the supervisor, their use would contribute to the prevention of injuries.

E. It is each employee's responsibility to work in a safe manner and to report unsafe conditions or procedures to their supervisor.

F. Horseplay, scuffling and other such activities are prohibited.

G. Crew tailgate safety meetings shall be held at least every 10 working days or when starting a new work activity. Meetings shall be documented and posted on the crew bulletin board until the next meeting.

II. INJURY, MEDICAL SERVICES, FIRST AID

A. An employee who is injured on the job shall report the work injury to their immediate supervisor as soon as possible, or at least before the end of the work shift, and before going to a doctor. If an injury requires treatment during off hours, the employee's supervisor shall be notified immediately and should accompany the injured employee to the doctor.

B. All employees shall be aware of the approved physicians, clinics and hospitals available in their immediate work areas. Names, addresses and telephone numbers of approved physicians and medical facilities shall be in all trucks and supervisors' offices.

C. At each worksite at least one crew member shall be trained in a standard first aid course equal to that of the American Red Cross Multimedia Course. To remain current, each employee shall be trained every three years. An approved first aid kit shall be provided and maintained in the crew's quarters.

D. Supervisors shall provide proper equipment and prompt transportation that will avoid unnecessary delay in emergency treatment of injuries.

E. A first aid kit must be available at the worksite. All supplies must be kept and maintained in a sanitary and usable condition.

III. VEHICLE OPERATION

A. All drivers shall perform a pre-operational (pre-op)check of their vehicles including rental equipment before leaving the yard. Be familiar with operator's manual. No vehicles or equipment are to be operated when in an unsafe condition.

B. All employees who are drivers or passengers of state vehicles, rental vehicles or private vehicles on state business shall wear seat belts and/or harnesses.

C. All employees operating equipment with roll-over protective structures shall wear seat belts.

D. All new employees expected to operate vehicles or equipment shall pass a road or operational capability test administered by the employee's supervisor or supervisor's representative and shall be qualified on each type of vehicle/equipment that the employee will operate on state business *before operating the vehicle/equipment unsupervised.*

E. Use proper mounting/dismounting techniques when climbing into and from vehicles/equipment. Face the equipment, use the hand and foot holds provided and do not jump off equipment.

F. Do not work under vehicles supported by jacks or chain hoists without adequate protective blocking or jack stands.

G. Vehicles/equipment are to be kept clean of any objects or materials which could fall off. Cabs are to be kept clean and orderly.

H. Do not work under a vehicle unless steps have been taken to prevent it from rolling. Use chock blocks or otherwise secure the vehicle to prevent movement: **do <u>not</u>** rely on the parking brake.

IV. <u>CHAPTER VIII</u>

A. Traffic control, shoulder closures and work area protection requirements shall be in accordance with Chapter VIII of the Maintenance Manual. When planning a lane or shoulder closure, everyone concerned must know what their job is and what is expected of them before going out on the road.

B. Whenever possible, avoid parking close to a highway, even for a short period of time. If a vehicle is not being used for the work or to protect workers, it should be parked where it will have no influence on passing traffic or block potential escape routes for workers on foot.

C. When vehicles are parked alongside the traveled way, enter and exit vehicles on the off-traffic side whenever possible, even though it may be inconvienient.

D. Do not walk around in an area where equipment is being operated until you let the person operating equipment know that you are there and that you are seen by them.

E. Unless there is a clear reason for doing otherwise, workers on the pavement or on an unprotected roadside, or landscaped areas, shall, insofar as is practical, continually face toward oncoming traffic. **This is the personal responsibility of every individual working on or near the highway.** If facing oncoming traffic is impractical, you should use a lookout.

F. Supervisors should plan work activities so as to minimize or eliminate the need for backing of equipment.

V. HAND TOOLS, POWER TOOLS, GUNPOWDER-ACTIVATED TOOLS.

A. Workers shall not handle or tamper with any electrical equipment, machinery, or air or water lines in a manner not within the scope of their duties, unless they have received proper instructions to do so from their supervisor.

B. Machinery shall not be repaired or adjusted while in operation, nor shall oiling of moving parts be attempted, except on equipment that is designed or fitted with safeguards to protect the person performing the work.

C. When equipment, machinery or power tools are used, guards shall be in place and properly adjusted. Any deficiencies in this regard are unacceptable and use of the equipment, machinery or power tool is prohibited.

D. Loose or frayed clothing, dangling ties, long hair, jewelry, etc., shall not be worn around moving machinery or other sources of entanglement. Only clothing and personal protective devices appropriate for the job shall be worn.

E. Hand tools, air tools, hydraulic tools and miscellaneous tools and equipment shall be inspected regularly to assure that they are in good operating condition. Report any deficiencies to the supervisor. Defective tools shall not be used.

F. Employees are not permitted to use certain equipment, such as chain saws and gunpowder actuated tools without proper training, licensing and approval. Safe practice rules and requirements for using these types of equipment and performing other specialty work such as welding and cutting, are found in the Equipment Index of the COSP; and these rules and requirements must be strictly followed.

VI. HAZARDOUS MATERIALS

A. All employees assigned to operations involving the use of chemicals shall have access to Material Safety Data Sheets (MSDS), proper training in handling procedures and be provided the necessary protective devices as required by the Departmental Safety Manual.

B. All employees shall be trained in the Caltrans Hazardous Material Communication Program.

C. Employees shall be trained in hazardous spill awareness. Drug lab paraphernalia, used hypodermic needles, medical waste, bombs or other explosive devices and other hazardous substances are occasionally discarded within the right of way. If any of these items are found, the supervisor should be notified immediately and the proper steps taken to insure that employees are not exposed. Unknown materials should be considered hazardous until identified by trained personnel.

D. Wash thoroughly after handling chemical pesticides or other hazardous substances, and before eating, smoking or using the restroom. Follow all special instructions on product labels, Pest Control Advisor recommendations, Material Safety Data Sheets and from other authorized sources.

E. When new products/ chemicals are introduced, supervisor shall ensure that the MSDS are reviewed and understood by all affected employees before any work with the product/ chemical is done.

VII. SPECIAL INJURY PREVENTION

A. Learn to recognize and when possible, avoid poison oak. Whenever it is necessary to work around suspected poison oak areas, wear long sleeve shirts and gloves, and wash with water and soap after any suspected exposure.

B. A significant number of lost time injuries involve the back. Be careful when lifting. Get help or use equipment, if necessary. When lifting heavy objects, lift properly. 1. get a firm footing. Keep feet apart (shoulder width) for a stable base; point toes out. 2. Bend your knees. 3. Tighten stomach muscles. 4. Lift with your legs. 5. Keep load close. 6. Keep your back straight.

C. Certain insects and snakes pose hazards. Learn to recognize their habitat and avoid them. If you must work in those areas wear the proper protective equipment: long sleeve shirts, high top work boots, and gloves.

D. Do not operate vehicles, tools or equipment if your abilities are impaired in any way due to fatigue, the effects of medication, controlled substances, alcohol or the complications of illness or injury. Working in this condition may limit the ability to perform your work in a safe manner. Notify your supervisor if you are taking any medication that could hinder your performance.

E. Hearing protection is required for any noise exposure above 90 decibles.

VII. REFERENCES TO APPENDIXES

1. Appendix A - Confined Space Entry Procedures.
2. Appendix B - Personal Protective Equipment Guidelines.
3. Appendix C - Trenching Safety Guidelines.
4. Appendix D - Cut Slope Safety Guidelines (Re: Departmental Safety Manual).
5. Appendix E - Instructions for Developing Individual and Site-Specific COSP's

DRAINAGE STRUCTURE CLEANING

HAZARD REVIEW

Moving traffic
Wedged objects
Moving equipment
Loose and slippery material within work area
Working in confined spaces

SAFE OPERATING PROCEDURES

1. Review safe practice rules for applicable equipment (including rental equipment) and perform pre-operational checks.
2. Review work area protection procedures and any traffic control requirements.
3. Park in an area suitable for safe entering or exiting of vehicle and which does not cause a hazard to yourself or others.
4. While on foot, make every effort to perform your work *facing* oncoming traffic.
5. Use standard personal protective equipment.
6. Employee should not dislodge wedged objects with his hands.
7. Employee should select the proper tool for the job.
8. A confined space entry permit shall be posted at the work site and must be completed and signed before the entry into any confined work space. (See Confined Space Appendix (A).
9. Workers on foot should stay out of the way of operating equipment until the area is clear for hand work.
10. Avoid operating equipment inside structures. Equipment operating underground may require special permit from Cal-OSHA. Be aware of possible carbon monoxide buildup and other sources of contamination.

SURFACE DRAINAGE CLEANING

HAZARD REVIEW

Moving traffic
Hidden hazards
Moving equipment
Overcrowding of workers

SAFE OPERATING PROCEDURES

1. Review safe practice rules for applicable equipment (including rental equipment) and perform pre-operational checks.
2. Review work area protection procedures and any traffic control requirements.
3. Park in an area suitable for safe entering or exiting of vehicle and which does not cause a hazard to yourself or others.
4. While on foot, make every effort to perform your work *facing* oncoming traffic.
5. Use standard personal protective equipment.
6. Before excavating in an unfamiliar area, inspect and determine if there are any buried utilities or other hidden hazards. If in doubt, you shall contact U.S.A. and your regional electrical office.
7. Workers on foot should stay out of the way of operating equipment until the area is clear for hand work.
8. Employees not involved in operation of equipment should avoid being in the vicinity of same until the area is clear for hand work.
9. Allow ample space for each employee to work safely.
10. Watch for tripping hazards and uneven ground.

REPAIR OR REPLACEMENT OF DRAINAGE FACILITIES

A special hazard review and safe operating procedure will be written by the supervisor for each individual job covered in this section.

The Code and Review shall incorporate those factors needed to cover the highly individualistic nature of this type of job.

Each employee shall review the Code of Safe Practices for the particular tools or equipment the employee will be using.

PUMP HOUSE MAINTENANCE

HAZARD REVIEW

Explosive Hazards
Oxygen Deficient Atmosphere
Footing and Falling Hazards

SAFE OPERATING PROCEDURES

1. Review safe practice rules for applicable equipment (including rental equipment) and perform pre-operational checks.
2. Do not go below floor level prior to notifying Area Supervisor or Area Superintendent, and the local dispatcher.
3. Before entering a confined space, a "Confined Space Pre-Work Check List" shall be posted at the work site and must be completed and signed by all employees involved in entering the confined space before entry into the confined space.
4. All employees, including standby persons, shall be trained in the operating and rescue procedures, including instruction as to the hazards they may encounter.
5. Employees entering confined spaces should be in good physical condition and psychologically suited for the job.
6. At least one person shall stand by on the outside of the confined space ready to give assistance in case of emergency.
7. Smoking or open flames shall not be permitted in any area of the structure. "No Smoking" signs shall be posted on all exterior doors of the pump house. If cutting or welding is required, remove the object to outside area, if possible. If removal is not possible, remove all grates, manhole covers and set up mechanical ventilation to provide maximum ventilation in the work area. Respiratory protection may be required.
8. The area shall be ventilated for a minimum of 15 minutes prior to atmospheric testing and entry. Pumping plants with wet pits need not be ventilated if the crew leader determines that the updraft of air is sufficient to indicate the natural ventilation system is functioning and the atmosphere required tests are satisfactory.
9. Atmospheric tests must be conducted by a trained and qualified person prior to any employee descending below the entry level of the pump house. If it is determined from the initial test, that the lower explosive level and oxygen levels are within acceptable and legal standards as mandated in Article 108 of the General Industrial Safety Orders, Title 8, California Code Regulations, then entry below the main floor may proceed. The air shall be continually monitored with an appropriate instrument for combustible gases and oxygen-deficient atmosphere. A record of such tests shall be kept at the job site. **Should the atmospheric-testing instrument's audible alarm or visual indicator indicate a dangerous condition, all individuals must evacuate the area immediately.**
10. Atmospheric detection instruments shall be stored at Supervisor, Area Superintendent, and Region Manager's office. These shall be certified annually and checked before each use. Detection instruments not operating properly shall not be used.
11. During the initial testing of structure for atmospheric conditions, all employees must remain at floor level.
12. A radio-equipped vehicle must be at the location when an employee(s) will be below the floor level. The radio shall be checked with local dispatcher for communication capabilities at the location (see Appendix C).
13. One person must remain at floor level at all times, and visual or verbal communication must be constantly maintained with employee(s) below the floor level.

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14. WRITTEN EMERGENCY RESCUE PROCEDURE MUST BE LOCATED IN PUMP HOUSE AND AT THE LOCAL DISPATCH OFFICE READILY AVAILABLE AT ALL TIMES. THE STAND-BY PERSON(S) SHALL FOLLOW THE WRITTEN EMERGENCY RESCUE PROCEDURES.
15. Notify the local dispatcher when all work below floor level has been completed and all employees have safely returned to floor level.
16. If the above conditions cannot be obtained, no one shall enter the confined space.

APPENDIX B

Personal Protective Equipment (PPE)

Following are requirements/guidelines for the use of personal protective equipment. The guidelines do not reflect the only instances where these devices are to be used. It is not possible that an appendix such as this contains guidelines for every possible situation; unusual circumstances may call for greater protective measures than are outlined here. It is the Supervisor's responsibility to exercise prudent judgement in the application of these requirements/ guidelines and to insure that all employees wear the appropriate personal protective equipment. The standard PPE includes a hard hat, orange vest and safety glasses. Non-compliance could result in needless injuries or corrective action.

Hard hats shall be worn:

- When working within the right-of-way.
- When there is a clear and present danger of falling objects which may cause injury.
- When exposed (or reasonably expected to be exposed) to falling or flying materials, contact with electrical hazards, or to hazardous chemical substances.
- At the direction of the Supervisor.

Orange vests or shirts shall be worn:

- While working within the right-of-way.
- When exposed to moving traffic.
- At the direction of the Supervisor.

Safety glasses shall be worn:

- When working near moving vehicles and equipment.
- When there is a risk of injury to the eye, such as punctures, abrasions, or contusions.
- At the direction of the Supervisor.
- While grinding, drilling, sawing or hammering.
- While operating various power tools such as, but not limited to, chain saws, weed eaters, hedge trimmers, leaf blowers, lawn mowers, lawn edgers, augers. Woodworking tools, pipe cutting and threading tools and powered metal cutting saws.
- While operating trenching machines, pavement breakers, concrete saws, rock drills, rock splitters, chipping and roto-hammers, and concreted mixers.
- While working on energized electrical equipment.

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Safety goggles shall be worn:

- When in the judgement of the Supervisor their use would be more appropriate than safety glasses alone.
- When there is a clear and present danger of a foreign object or substance entering through the side of the glasses.
- When there is a need to protect the eye from mists and dusts.
- While engaged in activities such as sandblasting.

Face Shields shall be worn:

- When in the judgement of the Supervisor their use should be more appropriate than goggles. (Sandblasting, etc.)
- When there is a possibility of injury to the face/neck area.
- When there is a danger of splashing chemicals or other hazardous substances. (Use special splash shield)
- When using drills or grinding equipment where safety glasses or goggles alone are not sufficient to prevent materials from injuring the employee.

Work Gloves should be worn:

- During any operation where there is a risk of abrasion, laceration, burns, blisters or puncture to the hands.

Note: Gloves will not protect against all hand injuries, but their use should minimize the number of minor injuries associated with hand work.

Some activities where gloves should be worn include:

- Hot mix paving or patching
- Fence and guardrail repair (includes gore attenuators)
- Median barrier repair
- Sign repair
- Delineation or culvert marker repair or replacement
- Tree trimming and associated activities
- Pruning of shrubs and other vegetation
- Welding and grinding
- Picking up litter and debris
- Weeding
- Operating pneumatic tools
- Using common digging tools such as shovels, picks, etc.
- Electrical work (when appropriate) example: relamping

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- Operating chain saws, weed-eaters and other gas powered tools

Impermeable gloves shall be worn:

- When working with hazardous chemicals.
- As directed by the MSDS.
- When using cleaning solvents.
- When mixing and applying pesticides.
- When mixing and applying methacrylate.
- When working with isocyanate-based concrete repair products such as Percol or Penatron.

Coveralls or long sleeved shirts should be worn:

- When exposed to hot materials while hot mix patching or paving, crack sealing, placing thermoplastic markings, using heated bituminous pavement marker adhesives and etc.
- When welding or cutting.
- When exposed to poison oak.
- When exposed to harmful dusts.
- When mixing and applying certain pesticides

Impermeable coveralls or Caltrans rain gear shall be worn:

- When mixing and applying certain pesticides.
- When mixing and applying methacrylate.
- When required by either a product label or the MSDS.

Rubber boots shall be worn:

- When mixing and applying methacrylate.
- When mixing and applying certain pesticides.
- When required by the product label or the MSDS.

Fall protection devices (approved belt and lanyard) shall be used:

- When in the bucket or basket of any personnel lift.
- While on overhead signs not equipped with safety railings.
- While on fixed ladders over 20 feet in unbroken length without cage protection.
- While working on unguarded work platforms where you can fall more than 7 1/2 feet.

Respirator protection (with the appropriate filters/cartridges) shall be worn:

- When required by the product label or MSDS.
- When welding or cutting on galvanized materials.
- When mixing and applying certain pesticides.
- When handling hazardous chemicals.

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- When sandblasting lead-based paints, see your supervisor for safe guidance

Hearing protection shall be worn:

- When noise levels in the work environment exceed 90 decibels.

  Example are:

  - Brush chipping
  - Sandblasting
  - Operating chain saws, weed eaters, blowers, etc.
  - Operating pneumatic tools (pavement breaker, etc.)
  - Operating Vactor/Jet rodder
  - Using compressed air to blow cracks
  - Operating mowers
  - Operating Sani-Vac
  - During avalanche control operations
  - Operating motorized Layton paver
  - Operating concrete saw
  - Steam cleaning

  The operation of motorized equipment such as dozers, graders, loaders, snow blowers, trenchers, gradalls, self-propelled pavers, rollers, pavement grinders, tractors, backhoes, kettles, sweepers, chip spreaders, mist blowers, stump grinders, mudjack machines, and certain trucks may require hearing protection. If the noise level of a particular vehicle appears to be excessive, the actual decibel reading for that piece of equipment should be determined through testing.

  A good rule of thumb is: If normal conversation at 3 feet cannot be understood without raising your voice, hearing protection is probably needed.

White coveralls shall be worn:

- While working in planned lane closures at night.
- When the supervisor feels that their use would increase employee safety.

Note: An orange vest must also be worn during daylight operations.

Reflective vests shall be worn:

- While working on or near the right of way at night.
- While exposed to moving traffic during the hours of darkness.

Clothing not appropriate for Caltrans use

- Cut-offs
- Tank tops that expose bare shoulders
- Sandals or canvas shoes
- Metal hard hats

Appendix D-2

Caltrans Maintenance Manual Volume One
Chapter 8, Protection of Workers

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

MAINTENANCE MANUAL

VOLUME ONE

Caltrans

MAINTENANCE MANUAL

VOLUME I

CHAPTER 8

PROTECTION OF WORKERS

CHAPTER 8

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8.00 Introduction

It is Caltrans policy to conduct its business in the safest possible manner consistent with applicable law, rule or policy.

This chapter of the Caltrans Maintenance Manual is a part of the Caltrans written injury and illness prevention program. It provides detailed instructions for Maintenance managers, supervisors and employees. It is designed to help employees in their efforts to work safely. All employees are expected to follow these minimum guidelines.

Other employee safety subjects are covered in the Maintenance Code of Safe Operating Practices, other chapters of this manual, and in the Departmental Safety Manual.

An important factor to be considered in employee safety is the false sense of security acquired when workers have not had a recent close call. It is also the hardest to protect ourselves, against. On rural routes, we may have only 100 vehicles pass per day. In a metropolitan District, we may have more than 333,000 vehicles pass each day within a few inches or feet of our work sites. In 1996, the California Highway Patrol arrested 91,988 motorists for Driving Under the Influence (DUI). In fact, eight of the last twelve highway workers killed on the job were struck by motorists that were DUI.

The most important part of our job is to protect ourselves from traffic, while getting our work done. We do this by:

(A) Letting the motorist know what's going on and where to drive.

For this we use signs, flags, barricades, cones, flashing amber lights, changeable message signs (CMS) and flashing arrow signs (FAS).

(B) Avoiding the errant driver.

Face traffic, stay aware through your own eyes and ears or those of a lookout who will warn you. Plan your escape route.

(C) Using protective equipment.

Protective vehicles, truck mounted crash cushion headrests and seat belts/shoulder harnesses.

(D) Planning the work to reduce employee exposure to traffic.

8.01 Managers and Supervisors Responsibilities

The following paragraphs summarize the basic elements of the Caltrans injury and illness and prevention program and define who is responsible for enforcing the safety and health policies and practices. For further information consult Chapter 1, the Caltrans Injury and Illness Prevention Program, in the Departmental Safety Manual.

(A) Supervisors and managers are the responsible persons to implement, maintain, and enforce Departmental safety rules and policies.

(B) Supervisors, in cooperation with training personnel, shall develop safety related training programs to ensure all employees receive:

(1) General training to cover hazards basic to all places of employment.

(2) Specific training to cover hazards that are unique to each employees' job assignment.

(C) Supervisors shall ensure that each employee is able to understand how to complete each assigned task safely.

(D) Supervisors shall ensure that each employee follows safe and healthy work practices and procedures.

(E) Supervisors shall keep abreast of safety and health regulations affecting the operations they supervise.

(F) Supervisors shall advise management of safety training needs of subordinates.

(G) Supervisors shall ensure that each employee is provided with the equipment, necessary to complete assigned tasks safely.

8.02 Work Site Safety

Caltrans commits to promoting an effective injury and illness prevention program. Managers and supervisors are responsible to:

(A) Routinely inspect all field and facility work areas under their jurisdiction to identify, document, and eliminate physical or environmental hazards that may contribute to injuries or illnesses. In order to accomplish this, Region Managers should do three or more safety reviews per month and Area Superintendents should do three or more field or facility safety reviews per week.

(B) Routinely review, study, and document all operating methods, practices, and procedures to reduce or eliminate the potential for injury or illness.

(C) Counsel, train, and discipline employees when appropriate to reduce human factors that contribute to injuries or illnesses.

(D) Investigate every injury or illness and vehicle accident to:

(1) Determine contributing circumstances, and

(2) Develop information that leads to correcting unsafe conditions and unsafe acts.

(E) Establish and maintain codes of safe operating practices, or equivalent, which identify hazards specific to job assignments.

(F) Enforce all rules, laws, and policies that will promote, protect, and preserve employee safety and health.

8.03 Individual Responsibilities

All employees shall do everything reasonably necessary to protect their own safety and health and that of others, by complying with all occupational safety and health policies, procedures, laws, rules, or regulations. They shall report all injuries, illnesses, or unsafe conditions to their supervisor at once, or before the end of the work shift.

All employees are expected to report to work mentally and physically capable of performing all of their assigned duties without jeopardizing the safety and health of themselves, other employees, or the public. They shall be free from the effects of medication, controlled substances, alcohol, or the complications arising from illness or injury, which might impair their judgment and/or ability to perform their work.

Employees are responsible to notify their supervisor of any personal medical condition or prescribed medication, which might impair their ability to perform their assigned duties. Employees should also report to their supervisor any behavior by an employee, which reasonably indicates that they are not fit for duty.

Supervisors or managers who observe an employee that appears to be unable to perform his/her assigned duties and have a concern about the safety of the employee or others, are responsible to prohibit that employee from continuing to work. The employee should be prohibited from working until a determination of the reason for the employees behavior is made, or until a medical evaluation of the employees fitness can be completed.

Any employee who violates any safety and health policy, procedure, regulation, law, or rule may be disciplined in accordance with the provisions described in the Caltrans Guide to Employee Conduct and Discipline.

Any supervisor or manager who fails to enforce safety and health policies, procedures, regulations, laws, or rules shall be disciplined in accordance with the provisions described in the Caltrans Guide to Employee Conduct and Discipline.

Supervisors and managers shall ensure that employee safety and health issues are discussed and assessed with employees at least annually at the time of issuing an Individual Development Plan/Performance and Appraisal Summary, and/or at the time supervisors discuss employee probationary reports.

Supervisors in office work settings should include discussions about health and safety matters at routinely scheduled staff meetings, but, at a minimum, shall have meetings with their employees at least quarterly to discuss safety and health issues.

Supervisors in field locations shall have tailgate safety meetings, at least every 10 working days in compliance with the requirements of the Construction Safety Orders, ß1509(e).

Supervisors shall also conduct meetings with employees when they are first hired, or when a new process, chemical, or procedure is introduced that contains a new or previously unrecognized hazard or when a new or previously unrecognized hazard is identified.

8.04 Responsible Person In Charge

It is practice and policy that whenever two or more employees are assigned to work together, one of the employees shall be placed in charge.

This responsibility is usually assigned to the designated supervisor or lead-worker based upon his/her civil service classification. However, there may be occasions when these individuals are unavailable to direct the work for given periods of time, or where emergencies arise that require non-supervisory employees to direct the work of others.

Supervisors must always designate an individual to be in charge during any planned absence, and identify the steps to be taken in the event of an emergency.

8.05 Changing Chapter Standards

Chapter 8 requirements are intended for the usual situations. Unusual circumstances may call for greater or lesser protective measures than are described here as standard. It is not possible, or even desirable, that a manual such as this contain detailed rules for every possible situation. It is up to the supervisor to exercise judgment in applying these measures. Supervisors should not, through the use of protective devices, create greater hazard to their crews by increasing the severity and/or duration of exposure.

Deviations from standard measures may be judged desirable by the supervisor for a variety of reasons such as sight distance, proximity of ramps or street intersection, restrictive width, short duration of job at one location, or minimal exposure because of volume, speed, and proximity of traffic. Decisions to reduce standard measures must have the written approval of someone responsible for the work at the Area Superintendent level or higher. This authority may be delegated to the Supervisor at the Districts discretion. This written approval shall describe the deviation and list the reasons it is needed. It shall be kept on file in the regional office for three years. This written approval is not needed in situations, which develop suddenly and unexpectedly and demand immediate action to prevent injury or harm to workers or the traveling public. Operations should be brought up to standard as soon as resources become available. The supervisor may increase worker protection using standard devices without approval.

The standard lane closure plans, Standard Plan T10 through T17, are for normal work zones and conditions. In unusual situations, the Maintenance Engineer may request the District Traffic Engineer to authorize a deviation at a specific location, providing:

(A) The specific location is identified by County, Route and Post mile.

(B) The deviation does not compromise the safety of workers.

(C) The deviation is not for general use throughout the District.

(D) The deviation and rationale are documented in District files.

The intent is to allow deviation at specific locations without creating individual District wide standard plans. A deviation could be allowed for an indefinite time at a specific location, if the special conditions remain unchanged.

8.06 Personal Protective Equipment

Caltrans provides the personal protective equipment (PPE) employees will need to work safely. This equipment is for worker protection and they shall use it properly to prevent injuries.

Personal protective equipment consists of many items. Hard hats, orange shirts, safety vests, safety glasses, earplugs or muffs, gloves, goggles, respirators, rain gear, and foot protectors are some examples.

The supervisor should select and provide the proper equipment and ensure workers wear it.

Refer to Appendix C of the Code of Safe Operating Practices and Chapter 12 of the Departmental Safety Manual for more information about personal protective equipment. Refer to Chapter 15 of the Departmental Safety Manual for a guide to using respiratory protection.

8.07 Emergency First Aid

All maintenance employees should be trained in Standard First Aid during the first three months of their assignment, and at least once every 3 years thereafter. All Tree Maintenance Workers and related classifications and all Electrical Workers and related classifications shall be trained in Cardio Pulmonary Resuscitation (CPR) during the first month of their assignment and then at least once a year thereafter. The training must be certified by the American Red Cross or other accredited organization.

An approved first aid kit must be available at each work site. First aid kits and supplies shall be kept in sanitary and usable condition and inspected at least monthly. The Departmental Safety Manual, Section 9.09 and 9.10, specifies size, location, and quantity of supplies for various categories of first aid kits.

For more information on first aid and emergency medical care see Chapter 9 of the Departmental Safety Manual.

8.08 Medical Treatment

Supervisors are responsible to ensure that if an injured or ill employee needs medical attention he/she will be taken to the nearest approved medical clinic, or hospital emergency room for treatment. Supervisors shall post the name and location of each approved medical service provider in a conspicuous place at each Caltrans work site. At a minimum, they shall be posted on designated bulletin boards in hallways or individual offices, and other appropriate locations, such as motor vehicles, that will ensure every employee is aware of the locations.

If the injury is serious an ambulance should be called.

A supervisor or designee shall always accompany the injured or ill employee to the medical facility.

As conditions warrant, the supervisor should talk with the attending physician to determine the extent of the injuries, the affected employee's recovery period and ability to return to work, and the employees ability to perform the full range of duties upon release.

The supervisor must describe to the doctor what modified duty is available so that the employee can return to work as soon as possible.

Employees shall report any work-related injury to their supervisor, immediately, or at least before the end of the work shift. They shall also report the injury to the supervisor before going to a doctor.

For more information on personal injury accidents and illnesses see Chapter 9 of the Departmental Safety Manual

8.09 Transportation of Workers

Workers shall be transported in vehicles equipped with seats and seat belts. Workers shall not be allowed to ride in the beds of dump trucks, buckets of loaders, or any other place on a vehicle that was not designed for driving or riding.

8.10 Relation of Chapter 8 to Chapter 7

Chapter 7 of this manual contains the separately published booklet, Manual of Traffic Controls (MTC), 1996 (Revision 1). The MTC is produced by the Traffic Operations Program. In case of any inconsistency between the MTC and Chapter 8 of the Maintenance Manual, Maintenance forces are to follow Chapter 8.

8.11 Definitions

Arrowboard	Refer to "Flashing Arrow Sign" or "FAS". The terms "arrowboard" and "flashing arrow sign" are synonymous.
Flashing Amber Light	This term includes such devices as flashing lights and rotating beacons.

Flashing Arrow Sign (FAS)	The Type I is an 8 feet x 4 feet (2400 mm x 1200 mm), trailer mounted FAS. The Type II is a 6' x 3' (1800 mm x 900 mm), vehicle mounted FAS. FASs have several modes. The caution mode has four lights flashing and the arrow modes flash right or left. See Section 8.21, The Use of the Flashing Arrow Sign.
Moving Operations	A moving operation is any work activity that moves along the traveled way slower than the prevailing speed of traffic. Some examples are striping, sweeping, etc.
Short Term Operation	A short-term operation is any work activity that can be performed in 10 minutes or less during light traffic volumes, without interfering with traffic or placing the employee in jeopardy. Some examples are pavement patching, removing a large piece of debris, etc.
Stationary Operation	A stationary operation is any work activity that includes workers on foot or equipment occupying any part of a paved shoulder or the traveled way at one location for more then 10 minutes. See exception noted in Section 8.28 (D) Moving Shoulder Operations.
Supervisor	The term supervisor as used here refers to any individual who has direction or control over another employee; however for approval of deviations, a supervisor is defined as one who is classified as a supervisor by his/her civil service classification.
Traveled Way	The traveled way describes that portion of the roadway where vehicles normally drive. This includes traffic lanes, turning lanes, and ramps. It does not include paved or unpaved shoulders or medians.
Truck Mounted Crash Cushion	The terms truck mounted attenuator (TMA) and truck mounted crash cushions (TMCC) are synonymous. The TMCC is designed to absorb kinetic energy. The TMCC softens the blow to our driver and usually reduces the impact to the motorist. While the TMCC on the truck reduces accident severity, it does not reduce the distance a vehicle will roll ahead when hit from behind.

8.12 Protective Vehicles

There are three classes of protective vehicles: Shadow, Barrier, and Advance Warning. All shadow vehicles and barrier trucks shall display a standard pattern of orange and white diagonal reflective striping on the back of the vehicle and/or the truck mounted crash cushion.

(A) Shadow Vehicle

A shadow vehicle is used to protect the work vehicle in a moving operation. A shadow vehicle shall:

(1) Have a truck mounted crash cushion (TMCC).

(2) Carry a FAS operating in the arrow mode while occupying a lane on multilane roads.

(3) On two lane roads, carry either a FAS operating in the caution mode or a flashing amber light.

(4) Be equipped with headrests.

(5) Be equipped with seat belt and shoulder harness.

(6) Be equipped with a two-way radio.

The shadow vehicle headrest protects the drivers' head and neck. The seat belt and shoulder harness prevent the driver from being thrown forward. Normally, the shadow vehicle shall be occupied by the driver only. However if a passenger must occupy the vehicle while it is shadowing, the passenger seat shall also be equipped with headrests and a seat belt and shoulder harness.

The purpose of a shadow vehicle is to provide physical protection for crews and their vehicles. The mass of the vehicle is the most important factor in protecting the driver of the shadow vehicle, the crews and the vehicles. The heavier the shadow vehicle, the better the protection, that is provided. A shadow vehicle shall have a Gross Vehicle Weight (GVW) greater than 19,800 pounds (9000 kilograms).

The shadow vehicle shall be positioned upstream from the work vehicle between approaching traffic and the vehicle it is protecting. It should be positioned where it will provide the best protection; not too close, or not too far back. It must be close enough to intercept errant vehicles, but far enough back to not roll ahead into the work vehicle. The shadow vehicle should remain approximately three seconds behind the work vehicle.

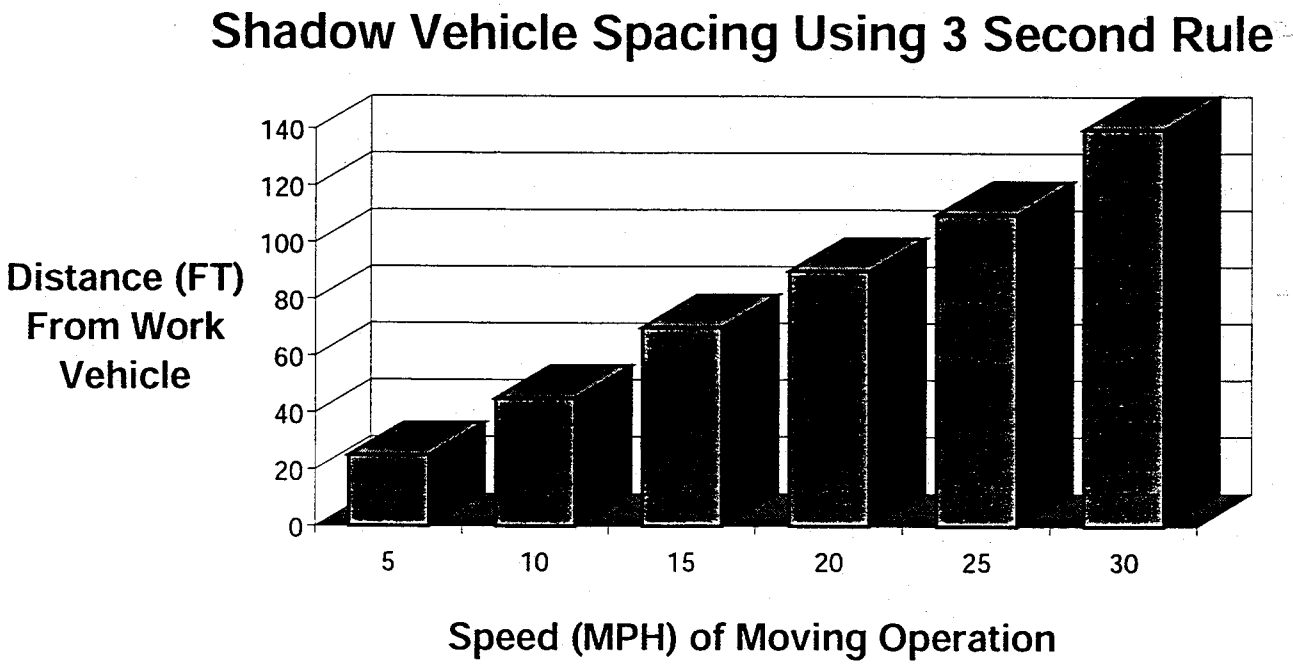


Figure 8-1: Shadow Vehicle Spacing

(B) Barrier Vehicle:

A barrier vehicle is an unoccupied vehicle or piece of equipment used to protect workers from errant motorists. Any vehicle at a work site can be used as a barrier because there is no minimum barrier vehicle size. However, workers shall use the heaviest vehicle reasonably available. In certain instances, more than one barrier vehicle may be needed. A barrier vehicle does not require a TMCC. However, if a TMCC is available, it should be used.

Any vehicle that is used should be parked upstream from the work site between approaching traffic and the workers. It should be parked where it will provide the best protection; not too close to the workers, not too far back. It shall be carefully positioned so that it will intercept errant vehicles, but will not roll ahead into the work area. Roll ahead may be controlled by proper brakes, sufficient space, angle parking and the transmission in gear or in park.

A barrier vehicle without a TMCC can be parked a number of ways. It can be parked at an angle or even straight across the lane. If it is parked at an angle, the front of the vehicle should be pointed away from traffic. The wheels shall be turned away from the work zone and away from traffic. This will avoid motorist panic and prevent secondary collisions if the barrier vehicle is hit and pushed ahead. A barrier vehicle with a TMCC should only be parked parallel with the direction of traffic.

(C) Advance Warning Vehicle:

An advance warning vehicle is driven or placed upstream from a work zone (refer to the Moving Lane Closure Plans T15, T16 or T17). It advises the approaching motorists of what conditions to expect ahead.

On the shoulder of a two-lane highway, it shall display either a FAS in the caution mode, or a flashing amber light/rotating light. On the shoulder of a multilane highway, a FAS with the "Flashing Arrow" displayed shall be used if the work vehicle is on the traveled way. A changeable message sign may be used instead, of a FAS.

If the vehicle encroaches into the traveled way, it shall be equipped as a shadow vehicle. If it encroaches into a freeway lane, the vehicle shall display a FAS in the arrow mode. If it encroaches into a two-way conventional highway, the FAS shall be in the caution mode or display a flashing or rotating amber light.

8.13 Planning Work To Reduce Worker Exposure

Managers and/or Supervisors shall plan work to minimize the amount of time employees are exposed to moving traffic. This can be done, by choosing proper work methods, combining operations, avoiding high traffic volume periods, and reducing the threat from non-attentive, speeding drivers.

Work methods and procedures should be designed to keep the amount of time workers are exposed to moving traffic to a minimum. For example, crews should be instructed to assemble in safe areas well away from the traveled way, convoy to the work site, and do their work expeditiously. Once work is completed, they should return immediately to a safe area.

In addition, when employees reach the work site, the work method should be designed to minimize the amount of time, workers spend on foot near moving traffic. The first choice should be to use mobile, power equipment to do the work. A worker in a piece of equipment is generally much safer than a worker on foot. The next choice of work methods would be to provide workers on foot with physical protection. For example, a barrier vehicle, guardrail, or some other obstacle can be used to provide physical protection. The last choice is to have workers on foot without physical protection.

In this situation, the work method should be designed so that workers can face traffic whenever possible and can work apart as individuals and not in groups, close together. If none of the above methods are possible, it may be necessary to have lookouts or a lookout alarm device or both. See Warning Systems - Lookouts, Section 8.16.

When a lane closure is planned, especially on freeways, managers and supervisors should contact all crews who could work within the closure. With more crews involved, more work can be accomplished. For example, along with roadway repair, stencil work, guardrail repair, electrical work, sign work, shoulder repair, sweeping, and landscaping can be completed. Not only will more work be completed, but more protective vehicles may be available at the work site, providing workers with increased protection. In addition to maintenance operations, managers should coordinate with District Traffic Operations, Surveys and other District units for work needs within the closed lane. This approach will reduce employee exposure to traffic. It will also reduce the number of lane closures required for routine maintenance.

When planning combined operations, managers and supervisors shall also plan the work so that each employee has enough space to work safely. They shall consult Crowding of Workers, Section 8.17.

Another opportunity to reduce worker exposure to moving traffic is to carefully plan work on the highway. When there are fewer vehicles on the traveled way, there are fewer vehicles with an opportunity to hit workers. Managers and supervisors should consider reducing employee exposure by requiring an unconventional workweek or extended and/or multiple work shifts to take advantage of these lower traffic volumes. Managers should also review maintenance projects for opportunities to improve worker safety with a complete facility closure.

Before short-term tasks are assigned, the supervisor will determine if the task has to be done immediately, or if it could wait. He/she shall decide if it could wait until formal traffic control will be set up and the job performed as a part of a combined operation. An example would be the removal of litter from a center median area. If the debris is not a safety hazard, could picking it up wait until a lane closure is set for another reason?

Supervisors shall plan all work methods to minimize the need for the backing of equipment and vehicles at the work site.

8.14 Working Near Moving Traffic

When working on or near the traveled way for any amount of time, workers must be aware of the hazards from errant vehicles. If available, a vehicle, regardless of its size, shall be used as physical protection from traffic. Workers on foot shall face traffic whenever possible. If two or more persons are working close together, a lookout may be necessary (consult Warning Systems - Lookouts, Section 8.16).

Employees should work quickly, but safely, and return to their vehicle as soon as work is completed.

When working on the outside radius of curves, workers should be aware that some vehicles, may have the tendency to drift to the outside.

Traffic on two lane conventional highways is often lighter than on freeways. Workers cannot let this fact lull them into a false sense of security.

When working on conventional two lane roads, employees shall be aware that errant vehicles can come into the work area from either direction. Many two-lane operations involve short-term work such as fixing guide markers, straightening signs, and litter removal. These operations involve workers on foot, often next to the traveled way. When employees are working by themselves, they must make sure that they use their eyes and ears to look and listen for danger signals to ensure their personal safety.

It is recommended that employees who need to be highly visible during the day should wear white coveralls and the proper warning garments as described in the Departmental Safety Manual, Chapter 12, Section 12.20, to increase their contrast with orange equipment.

8.15 Facing Traffic (Employees on Foot)

The Supervisor shall plan and supervise the work to minimize the amount of time workers will have their backs to traffic.

Unless there is a clear reason for doing otherwise, employees shall continually face oncoming traffic while working on or near the traveled way. This is the personal responsibility of every worker.

Facing traffic is the most important thing workers can do to protect themselves and their coworkers while working on or near the traveled way. Facing traffic gives workers a better opportunity to see and hear errant vehicles. This allows them a chance to move out of the way and warn fellow workers.

8.16 Warning Systems-Lookouts

While working on foot on or near the traveled way, workers should normally be protected by barrier vehicles, guardrail, or other physical means. Where the absence of such physical protection exposes workers on foot to errant vehicles, a person shall be assigned as a lookout according to circumstances described below.

A lookout shall be assigned if all of these conditions exist:

(A) Work occurs on a roadway with a posted speed limit of 55-mph (88 kph) or more.

(B) Workers are without physical protection.

(C) Two or more people working close to each other.

(D) Working within 30 feet (9 meters) of moving traffic.

(E) A person is on foot.

The lookout shall continually watch approaching traffic for errant vehicles that may hit workers on foot. If trouble is suspected, the lookout shall warn the workers by yelling, using a vehicle or warning horn, a portable lookout alarm device or any system capable of communicating the warning message. This warning is intended to give workers the time to use a planned escape route to avoid the errant vehicle.

A lookout shall not be assigned any other duties.

Lookouts shall be rotated often enough to keep them alert.

The supervisor may use a crew lookout whenever he or she thinks it is needed. Even if workers are physically protected, using a lookout may be beneficial.

Electrical and mechanical detection systems may be used to supplement the human lookout.

Slope watchers shall be used when working under unstable slopes where rocks may fall and injure workers. These slope watchers shall not be assigned to watch the slope and to lookout for traffic at the same time. Refer to the Maintenance Code of Safe Operating Practices, Slope and Embankment Maintenance, and Appendix D, Cut Slope Safety and the Departmental Safety Manual, Chapter 21, Cut Slope Safety.

8.17 Crowding of Workers

Supervisors shall plan work so that each employee has adequate space to work safely.

Supervisors shall ensure that employees know their responsibilities for positioning themselves so that each employee has enough work space to work safely and avoid being struck by flying material or another worker's tools.

Workers shall avoid unnecessary gatherings, which increase accident exposure and cause public

concern.

8.18 Access to Median Work Zones

(A) Workers should not walk across traffic lanes to work in median areas. They shall drive into the median area and park when possible. However, the width and condition of the median must be considered. If the area is too narrow, wet, sandy or is difficult to accelerate from, it should be avoided.

(B) If it is not possible to park in the median area and crossing on foot is necessary, the following rules must be followed:

(1) Workers shall not run. They shall wait for a break in traffic adequate to allow them to walk across the lanes.

(2) Workers shall not carry tools or items that would slow them down and make the crossing unsafe.

(3) If the traffic is too heavy and a traffic break is not available, workers shall wait for a safer time to do the job. If they must cross, they shall call for traffic control or ask for a CHP traffic break.

8.19 Picking Up Litter and Debris

Normally, the safest way to pick up litter is to work individually and always, face approaching traffic. Trucks should be parked away from the work area, unless needed to provide protection from traffic. The workers may be dropped off and picked up later. The practice of employees walking beside a truck loading litter with a pitchfork or other hand tool should be avoided.

In narrow medians protective vehicles may be necessary at both ends of the work area.

Litterbags should not be filled so full that they will be too hard to lift. The bags should be placed where workers can easily pick them up with minimum exposure to traffic. When possible, the bags should be stockpiled to reduce the number of stops needed for bag removal.

Hypodermic needles should not be placed in the bags. For more information, refer to the special instructions for the Disposal of Hypodermic Needles in the Maintenance Code of Safe Operating Practices. Other sharp objects, heavy metal objects, tire caps, or concrete chunks should not be placed in litterbags. These items could seriously injure the person who picks them up.

When retrieving debris from a freeway lane, workers shall wait for a break in traffic. A break in traffic is defined as all lanes clear of traffic long enough for the employee to walk out, retrieve the debris, and walk back to the shoulder. If no traffic breaks occur, the California Highway Patrol should be contacted to provide one.

Workers shall not try to flag traffic or use hand signals to create a traffic break.

When debris is retrieved from the traveled way, workers shall follow these guidelines:

(A) Workers shall remain in the vehicle until the traffic break approaches.

(B) An escape route shall be planned before leaving the vehicle. The vehicle shall not be parked where it will block the workers' escape route.

(C) When workers are on foot, their vehicle shall be kept between themselves and approaching traffic. Workers shall walk on the outer edge of the shoulder, staying as far from moving traffic as possible.

(D) Workers shall always face approaching traffic.

The above procedures, except the traffic break, should be followed when removing debris from shoulders.

8.20 Maintenance Crews Working Across From Each Other

Maintenance crews shall not work on opposite sides of a highway, directly across from each other.

Work sites on opposite sides of a conventional highway or on opposite sides of one roadway of a divided highway should be at least 2000 feet (600 meters) apart. However, if the traffic is positively controlled by flaggers, stop signs, or traffic signals, the work sites can be closer.

8.21 The Use of the Flashing Arrow Sign (FAS)

Arrow messages pointing left, right, or to both sides, are to be used as action messages. An arrow is to be used only when requiring the motorist to change lanes. An arrow message is not to be used when a vehicle is parked in a closed lane unless it is being used for the arrow closing that lane.

In the flashing arrow mode, all lamps forming the arrowhead and shaft shall flash on and off simultaneously. During hours of darkness the FAS shall be dimmed to prevent the halloing and blurring of the arrow image.

To alert the motorist to work activity near, but not on the traveled way, the caution mode of the FAS is to be used.

Any shadow vehicle working on the traveled way of a multilane highway outside of a lane closure must be run with a FAS board in an arrow mode.

Work vehicles that are being shadowed should usually not display a FAS. Two partially superimposed FASs may not give a clear message.

8.22 Flashing Amber Lights and Rotating Amber Lights

Amber lights shall be used to alert motorists to work activity near, but not on, the traveled way.

Flashing and/or rotating amber lights are to be used on motor graders, snow removal equipment and other specialized equipment that are operated on the traveled way at lower than prevailing traffic speeds.

Flashing amber/rotating lights are to be used on pilot cars not having a FAS.

Amber lights are not to be used while driving at prevailing speeds, when parked in an established lane closure, or when no danger to the employee or motorist exists. Warning lights, to be effective, must only be used when they are needed. A flashing amber light should not be used at the same time as a flashing arrow sign because the arrow becomes more difficult to read.

During the hours of darkness, amber lights should be used with discretion. At times, the vehicles emergency flashers may be more effective.

8.23 Signs

Advance warning signs shall be placed when a stationary operation is on the traveled way or is on the shoulder within 6 feet (1.8 meters) of a traffic lane on a multilane highway with a paved shoulder 8 feet (2.4 meters) or more in width. Also, warning signs shall be placed well in advance of the work, when traffic slows, changes lanes, or moves from its normal course of travel because of the work. The standard signs shown in the 1996 Caltrans Manual of Traffic Controls and in Standard Plans T10 through T17 shall be used.

Portable signs should be placed on sign standards with two or more orange flags. The sign standard shall be in an upright position with the center of the sign panel a minimum of 5 feet (1.5 meters) above the pavement. A cone shall be placed next to each warning sign. If portable signs are displaced or overturned, from any cause, during the progress of work, they shall be immediately replaced in their original locations.

A barrier vehicle or a shadow vehicle shall be used as protection from traffic while setting and retrieving warning signs. A shadow vehicle shall be used as a protective vehicle during the installation and retrieval of traffic cones and signs in the taper and tangent sections of a lane closure.

When work is temporarily stopped or finished and traffic is not affected, all signs shall be promptly removed, dropped down or turned away from traffic. Using signs that do not affect traffic will reduce their effectiveness. In addition, installing them when they are not needed will increase worker exposure to traffic.

Extra warning signs may be used, when appropriate. For example, if queues are expected to develop in lane closures with reversible control, extra 'Prepare to Stop' signs can be installed.

Placing an advance warning sign, such as a 'Road Work Ahead' sign, on the rear of a work vehicle is inadequate and is not permitted. However, an advance warning sign may be used on an advance warning vehicle.

Signs on vehicles with messages such as 'Warning - This Truck Makes Frequent Stops' are advisory only and do little to protect the workers. They should only be used on low speed roads or city streets. When this type of sign is used, an amber light or FAS in the caution mode shall be used along with it.

Signs, such as 'Loose Gravel', 'Fresh Oil', etc., may be placed on barricades. The barricades shall be ballasted by means of sandbags placed on the lower parts of the barricade frame or stays. The sandbags shall not be placed on top of the barricade nor, over any reflectorized barricade rail facing traffic.

8.24 Lane Closures

A lane closure shall be set if a stationary operation takes more than 2 feet (0.60 meters) or reduces the width to less than 10 feet (3 meters) of an existing lane on a multilane highway. To take up to 2 feet (0.60 meters) of a lane on a multilane highway without a lane closure, a cone taper shall be installed that begins at least 300 feet (90 meters) upstream from the work area. The taper shall have 28 inch (700 mm) cones spaced 50 feet (15 meters) apart.

The lane of a two-lane highway shall be closed if work reduces the width of a lane to less than 10 feet (3 meters). Traffic shall not be moved across the center stripe without a lane closure or other means of traffic control.

A space of 6 feet (1.8 meters) should be maintained, whenever possible, between moving traffic and the work area.

When closing a lane, a barrier vehicle or a shadow vehicle shall be used for the installation of the signs and the FAS if they can be placed while off the traveled way on the shoulder or median. A shadow vehicle or a barrier with a TMCC shall be used as the protective vehicle during the installation and retrieval of traffic cones and signs in the taper and tangent sections of the lane closure. All devices placed in areas with no shoulders from an open lane require the use of a shadow vehicle for protection.

Lane closures shall be placed according to the Standard Plan T10, Traffic Control System for Lane Closure on Freeways and Expressways or the Standard Plan T11, Traffic Control System for Lane Closure on Multilane Conventional Highways.

If a lane closure begins to cause traffic to back up (commonly called queuing), the advance warning signs shall be moved back in advance of queuing. If the signs cannot be moved back, the lane closure must be removed. If the lane closure results in a significant traffic delay, the closure may need to be removed.

A Changeable Message Sign (CMS) may also be used to redirect traffic and relieve queuing. The additional CMS may be used at key interchanges and exit ramps and other locations where traffic queues may be expected due to maintenance activities.

8.25 Placing the Flashing Arrow Sign (FAS)

The flashing arrow sign (FAS) should be placed on the shoulder at the beginning of the taper as shown in Standard Plan T10. If there is no shoulder, the FAS should be placed as close to the beginning of the taper as possible. A minimum 1500 feet (450 meters) of sight distance shall be provided where possible for vehicles approaching the first FAS.

If the FAS cannot be located properly, consider placing the taper in a different or safer location.

In multilane closures on freeways and expressways (Standard Plan T10), one FAS must be used for each lane closed. The first FAS used should be a Type 1 (4 x 8 feet) (1200 mm x 2400 mm). The second and succeeding FAS may be either a Type 1 or Type 2.

8.26 Closing Auxiliary Lanes

Work occurring at the beginning of an auxiliary lane such as a truck lane or lane added to increase capacity, will require as a minimum the shoulder closure plan shown on Standard Plan T10 plus these additional requirements:

(A) A road work ahead (C23) sign instead of the shoulder work ahead (C24) sign on the shoulder upstream from the beginning of the auxiliary lane.

(B) Cones on the shoulder stripe from the C23 sign continuously to the auxiliary lane line.

(C) A land closed (C30) sign in the closed lane about 100 feet (30 meters) from its beginning and every 2,000 feet (600 meters) after that.

If the work site is a considerable distance from the beginning of the auxiliary lane and the above method is not practical, the lane shall be closed according to the Standard Plan T10. If the auxiliary lane is located at an exit ramp or connector, the closure plan in Standard Plan T14 shall be used.

8.27 Flagging Operations

Any time two-way traffic must share the same lane because of work in the other lane, a flagging operation must be set up. See Standard Plan T13.

Flaggers shall receive on the job training before going on duty and shall follow the flagging procedures described in the 1996 Caltrans Manual of Traffic Controls, Revision 1, Section 5-02.5, One Lane, Two Way Traffic Control and Section 5-04, Hand Signaling Control. They should be rotated and relieved periodically to maintain alertness.

In areas where flagger visibility is reduced, it is recommended that flaggers wear white coveralls and the proper warning garments as described in the Departmental Safety Manual, Chapter 12, Section 12.20. This will increase the flaggers' contrast with orange equipment and will make them more visible to approaching traffic.

On some two-lane roads one flagger may be used to control traffic. Traffic volume must be very light and the length of the one lane section should be short so that one end is visible from the other. The sight distance for approaching vehicles must be long enough that traffic can be safely controlled from one end of the work zone. This method must be approved by the Supervisor.

The cones on the centerline shown in Standard Plan T13 may be eliminated at the Supervisors' discretion if a pilot car is used. The pilot car shall have radio contact with personnel in the work area and the maximum speed of the pilot car through the traffic control zone shall be 25 miles (40 kilometers) per hour.

The minimum distance required between the flagger and the work area is listed in Table 1, Standard Plan T13.

Flaggers shall be used when the drivers vision is impaired because of smoke or dust in work zones. They shall also be used to protect trucks that must turn on the traveled way to load or dump. The flagging procedures in the 1996 Caltrans Manual of Traffic Controls, Revision 1, Section 5-02.5, One Lane, Two Way Traffic Control and Section 5-04, Hand Signaling Control shall be followed.

Where the end of a one-lane section is not visible from the other end, the flaggers shall maintain contact by means of radio or field telephones.

Except for unusual circumstances or emergencies, flaggers should not be used on freeways.

Traffic signals may be used to control traffic on two lane roads. The operation must conform to Section 9-03 of the Caltrans Traffic Manual.

8.28 Standard Exceptions to Lane Closure Procedures

(A) Limited Work on the Traveled Way, Without Lane Closures.

Short-term operations may be conducted on the traveled way without using a lane closure or signs. Pothole patching and debris retrieval, are examples of brief operations. To use this method all of the following conditions must exist:

(1) The traffic volume must be light. This means the worker can walk from the shoulder to the site on the traveled way, do the job and walk back to the shoulder without interfering with traffic.

(2) Sight distance shall be at least 500 feet (150 meters) in each direction. Where 500 feet (150 meters) of sight distance is not available at the work site, one or more lookouts may be posted to extend visual coverage.

(3) Vehicles must be parked completely off the traveled way.

If all three of these conditions exist, the supervisor may instruct workers to perform the work on a specified section of highway without a lane closure. All of the following work methods shall be used:

(a) When the crew consists of at least two workers, one of the workers shall act as a lookout. The lookouts exclusive duty will be to continually watch for approaching traffic and to warn the worker whenever trouble is suspected.

(b) The lookout shall not carry a flag or paddle and shall do nothing to control or influence traffic. All workers shall be off the traveled way when traffic passes.

(c) Only one production worker shall be on the traveled way, unless more are needed to reduce the exposure time.

(d) Workers shall face approaching traffic whenever possible.

(e) Workers shall have a planned escape route.

(f) A FAS in the caution mode or a flashing amber light shall be operating.

(g) Road Work Ahead (C23) signs are not required, since passing traffic is not to be affected.

(B) Pavement Marking and Relamping Operations

A supervisor may allow pavement marking and relamping operations on the traveled way without a lane closure. The posted speed limit must be less than 55 miles (88 kilometers) per hour and the work must take less than 10 minutes to complete. The supervisor may also use devices such as signs, barrier vehicles, and lookouts to increase worker protection.

(C) Chain Controls

Lane closures are not required in chain control operations. However, on multilane highways, they may be used to create a cushion between Caltrans workers and fast vehicles leaving the snow area. In addition, a supervisor may use lookouts and barrier vehicles to increase worker protection.

(D) Moving Shoulder Operations

The supervisor may allow moving shoulder operations next to the traveled way without a lane or shoulder closure. Shoulder grading, mowing, and spraying operations are examples of moving shoulder operations. The work must leave at least 10 feet (3 meters) of the lane next to the shoulder open to traffic. On two lane conventional highways, traffic shall not be moved across the center stripe without a lane closure or other means of traffic control.

8.29 Moving Lane Closures

Any slow moving, unshadowed vehicle working in a freeway lane outside a lane closure shall have a TMCC and FAS or it shall be followed by a shadow vehicle. The only exceptions to this rule are tow trucks and snow removal/de-icing equipment.

Before employees work in a moving lane closure, a discussion should be held so that all involved employees will know what their role in the operation is and how to proceed safely.

For information on vehicle spacing, vehicle positioning, and signing refer to the Traffic Control System For Moving Lane Closure On Multilane Highways (T15 and T16) and on Two Lane Highways (T17).

All vehicles used as shadow trucks shall be equipped as defined in Section 8.12, Protective Vehicles. Radio communication in all vehicles is required.

Other requirements, for moving lane closures and shadowing moving operations, found in the Maintenance Code of Safe Operating Practices, shall be followed.

8.30 Shoulder Closures

Shoulder closures are used to guide motorists around stationary operations on shoulders. A shoulder closure is optional on unpaved shoulders and two-lane roads. It must be kept in mind that shoulder closures provide no physical protection.

A shoulder closure is required for a stationary operation on a multilane highway with a paved shoulder 8 feet (2.4 meters) or more in width whenever vehicles or equipment are parked on the shoulder within 6 feet (1.8 meters) of a traffic lane. Shoulder closures are to be set up as described on Standard Plans T10.

Shoulders used as part time lanes should be closed in the same way as lanes are closed.

A properly placed barrier vehicle shall be used with shoulder closures to protect workers.

8.31 Parking

Before a vehicle is parked, the driver shall consider if the vehicle will be needed to perform the work. If not, the vehicle should be used for the physical protection of workers. If it is used for protection, refer to Section 8.12, Protective Vehicles. If it will not be used for physical protection or for work, the vehicle shall be parked where it will not affect passing traffic.

All vehicles should be parked on the same side of the highway (see Section 8.20, Maintenance Crews Working Across From Each Other).

If a vehicle is parked on the shoulder within 6 feet (1.8 meters) of a traffic lane on a multilane highway with a paved shoulder 8 feet (2.4 meters) or more in width for more then 10 minutes then the shoulder must be closed as shown in Standard Plans T10. This is not necessary on city streets where parking is expected.
Whenever possible, a vehicle shall be entered and exited on the side away from traffic, even though

it may be harder to do so. This will reduce worker exposure. If possible, workers shall not stand or work near the back of vehicles. Also, whenever possible, workers shall not work directly in front of vehicles.

8.32 Night Work

Extra caution is necessary at night when both motorists and workers visibility is reduced.

Each employee must be informed about the hazards of working at night.

Careful planning is necessary and all the potential problems that may be encountered while working on or near the traveled way should be considered.

During the hours of darkness, workers on foot must wear the proper warning garments as described in the Departmental Safety Manual, Chapter 12, Section 12.20, and white coveralls. However, Supervisors should not require white coveralls in snow or fog areas where a mostly white background might lower worker visibility. Supervisors should not require white coveralls in weather requiring rain gear.

The rain gear jacket shall be reflectorized for nighttime wear. Reflective material may also be worn on hard hats.

Sufficient light should be provided at the work site. Light plants, floodlights, or work lights shall be mounted and directed in a manner to allow employees to work safely and to prevent glare to approaching traffic.

Because of the risk to workers, nighttime call outs should be kept to a minimum. If there is no danger to the public, repairs should wait until the next day. For example, if the damaged facility does not encroach on paved shoulder areas or is more than 3 feet (900 mm) from the traveled way in unpaved shoulder areas, there should not be a nighttime call out except to place barricades. It is up to the Supervisor to decide when it is appropriate to call out a crew for quick, temporary repairs or to wait until daylight.

Call outs should be made when warning or regulatory signs have been knocked down and pose immediate danger to the motorist. Also, Supervisors should consider responding at night for broken water lines, damaged phone or electrical lines, or spills where environmental damage may occur.

Each District will advise all local law enforcement agencies of this call out policy.

During nighttime lane closures, all traffic cones should be retro-reflective as described in the 1996 Caltrans Manual of Traffic Control, Section 5-05.6, Revision 1, Channelizing Devices.

If the one-piece solid, opaque sleeves are used for retro-reflection, they should be removed during daylight hours. If banded or transparent reflective sleeves are used, they can be left on the cone during daylight hours.

All warning signs used at night shall be made with high performance reflectorized sheeting.

During hours of darkness, the lights on the Flashing Arrow Sign shall be dimmed to prevent the halloing and blurring of the arrow image.

8.33 Working Equipment Against Traffic

Operating equipment against traffic is permitted when working on the shoulder or within a lane closure. This may be desirable in some cases. For example, during crack sealing operations, employees would have the added protection of the work vehicle between themselves and approaching traffic. Headlights shall be turned on during the daylight hours when working against traffic. They should be turned off at night when working against traffic because they might confuse motorists.

8.34 Operating Maintenance Equipment

Caltrans owns many types of equipment. Employees may be expected to operate anything from a sedan to a snow blower; from pruning shears to chain saws; and from hammers to powder actuated nail guns.

Supervisors should allow only trained employees to operate equipment. When a qualification program is in place for a given type of equipment, employees shall not operate equipment unsupervised, until, they have been qualified by the Department.

Trucks or other mobile equipment which leave a freeway lane, that is open to the public, to enter the construction area, shall slow down gradually in advance of the location of the turnoff to give following public traffic an opportunity to slow down. When leaving a work area and entering a roadway carrying public traffic, the equipment, whether empty or loaded, shall in all cases yield to public traffic.

All equipment shall be operated as designed by the manufacturer. All manufacturers' safety directions shall be followed.

Operators shall not repair equipment unless they have been properly trained to do so.

8.35 Tailgates of Trucks

Workers shall not use their hands or fingers to clear debris from the tailgates of dump trucks. They shall use a shovel, digging bar or other device to remove debris.

8.36 Compressed Air

Air under pressure, if not properly handled, can be hazardous. Air nozzles shall not be pointed at a worker's body to dust off clothing.

Tanks or drums shall not be filled with compressed air, if they were not, designed to be used as an air tank.

Air hoses shall be checked regularly to ensure that they are in good condition. Cracked or leaking hoses shall be removed from service and replaced. Compressed air tanks should be checked and drained weekly.

Compressed air-tank operating permits should be conspicuously displayed and kept current. Air tanks shall be inspected as required by the Unfired Pressure Vessel Safety Orders, ß461.

All compressed air equipment and plumbing shall meet the requirements of the Unfired Pressure Vessel Safety Orders.

8.37 Working On Machinery And Equipment

Workers shall not work on electrical or mechanical equipment unless they are competent to do so.

Every power driven machine equipped with lockable controls or readily adaptable to lockable controls shall be locked out or positively sealed in the "off" position during repair, servicing or adjusting work. Machines not equipped with lockable controls or readily adaptable to lockable controls shall be de-energized or disconnected from its source of power. In all cases, accident prevention signs and/or tags shall be placed on the controls of the machines during repair work.

No one shall remove the tag or unlock the switch except the person who placed it.

During repair, machines or equipment shall be effectively blocked or otherwise secured to prevent inadvertent movement if such movement can cause injury to employees.

For example, before working underneath any vehicle and/or equipment to adjust or inspect it, steps shall be taken to ensure that the vehicle cannot move. Shut off the engine, set the brakes and physically block the wheels with wheel chocks before any work begins.

Remove the keys from the vehicle and place a 'Do Not Operate' tag in the ignition switch, on the steering wheel or some other very visible location. When working on a motor grader or other equipment that has implements such as blades, plows or buckets attached, you must lower them to the ground or block and/or chain them up before working underneath them.

Never get under a vehicle supported only by a jack. Use an approved safety stand designed to allow workers underneath the vehicle that is rated for the weight that they are expected to carry.

Do not work under a raised dump bed or other raised vehicle bed, unless the safety stand is in place. Raise the bed, place the stand in its holder and lower the bed onto the stand before beginning the work.

Depressurize air and hydraulic hoses before working on them. Do not search for hydraulic leaks with your hands; use a piece of wood or cardboard. Hydraulic fluid or air under pressure could enter your skin and cause serious injury.

Bleed pressure on spray tanks before opening or working on them. This includes chemical spray tanks, emulsion tanks on trucks or trailers, and even Hudson type pump sprayers.

Before adjusting, cleaning or repairing brush chippers, read the operators manual and take steps to ensure that all potential energized parts have been locked out. This includes the guillotine guards on those so equipped and all parts of the rotating drum.

This information is provided to help employees comply with the General Industry Safety Orders, ß3314, Cleaning, Repairing, Servicing and Adjusting Prime Movers, Machinery and Equipment.

8.38 Work On Electrical Circuits

Only qualified persons shall work on electrical equipment or systems. All work performed directly on or in proximity to electrical installations, equipment or systems operating or intended to operate on systems of 600 volts or less shall comply with the Low Voltage Electrical Safety Orders. All work performed on systems operating at more than 600 volts shall comply with the High Voltage Electrical Safety Orders.

The Codes of Safe Operating Practices for work performed on electrical equipment or systems contain more information on the specific hazards and on the proper safety procedures to follow while performing the work.

This section does not apply to installations of conductors and equipment in vehicles, operating at less than 50 volts or to their ignition systems.

8.39 Working Near Utilities

(A) Overhead Utilities:

Workers shall not be required or permitted to perform any function in proximity to energized high voltage lines. Any activity where any parts of tools, machinery, materials or any part of an employee's body will come closer than the minimum clearances from energized overhead lines set forth in the following table is prohibited.
Boom equipment must not be operated where the boom could come within the minimum required clearance set forth in this table. Hoisting over energized lines is prohibited.

Nominal Voltage (Phase to Phase)	Minimum Required Clearance (Feet)	Minimum Required Clearance (Meters)
600.....50,000	10	3
Over 50,000 75,000	11	3.4
Over 75,000 125,000	13	4
Over 125,000. ..175,000	15	4.6
Over 175,000.. .250,000	17	5.2
Over 250,000... 370,000	21	6.4
Over 370,000.... 550,000	27	8.2
Over 550,000...1,000,000	42	12.8

Figure 8-2: Overhead Utilities

Any overhead conductor shall be considered to be energized unless and until the person owning or operating such line verifies that the line is not energized and the line is visibly grounded at the work site.

If downed power lines are located, workers shall not try to move or repair them. They shall stay clear and call the experts; normally, the local power company will respond.

(B) Underground Utilities:

Before any digging or excavations are begun, the area shall be checked to determine if there are any buried utilities. Some examples of digging or excavations requiring checking would be installing a new sign post, guide marker, snow pole, shoulder grading or ditch/culvert cleaning. Utility markers or buildings that have no above ground source of power can indicate underground utilities. If the excavation will be conducted in an area, which is known, or reasonably should be known, to contain subsurface installations, only hand tools shall be used for digging.

The Superintendent or Supervisor shall notify the appropriate regional notification center for operators of subsurface installations at least 2 working days, but not more than 14 calendar days, prior to commencing any excavation with power tools.

The regional notification centers include but are not limited to the following:

Notification Center	Telephone
Underground Service Alert Northern California (USA)	1-800-642-2444
Underground Service Alert Southern California (USA)	1-800-422-4133
South Shore Utility Coordinating Council (DIGS)	1-800-541-3447
Western Utilities Underground Alert, Inc.	1-800-424-3447

If the excavation will be conducted in an area which is known, or reasonably should be known, to contain Caltrans electrical facilities, the Superintendent or Supervisor shall notify the Electrical Supervisor for the area, prior to commencing any excavation.

8.40 Confined Spaces

Workers need to be aware of confined space hazards.

A confined space is any location that meets the following definition:

1) an employee can physically enter, and

2) has limited or restricted means of entry or exit, and

3) is not designated for continuous employee occupancy.

For Caltrans employees, confined spaces include structures or facilities such as tanks, bridge cells, shafts, pits, bins, tubes, pipelines, deep trenches, vaults, vats, pump houses or compartments, sewage lift stations, culverts, cofferdams, elevator pits, or similar locations.

No person will be allowed to enter a confined space unless all workers involved have been trained in the operating and rescue procedures and have reviewed the Departmental Safety Manual, Chapter 14, Confined Spaces and the Maintenance Code of Safe Operating Practices, Appendix B, Confined Space Entry Procedures. Supervisors must ensure workers are properly trained and have read this material and understand it.

All employees who are designated as hands on users of instruments for testing for hazardous gases and oxygen deficiency must be trained in Confined Space Safety every 2 years.

8.41 Trench And Excavation Safety

Employees shall review the Maintenance Code of Safe Operating Practices, Appendix D, Trench and Excavation Safety Guidelines before working in or near trenches or excavations. Supervisors shall ensure employees understand and follow these guidelines.

Caltrans workers shall not enter any trench or excavation that has been dug by others until a supervisor or superintendent has inspected the trench/excavation and the surrounding area to identify and/or correct any hazards. The supervisor or superintendent must be competent and knowledgeable about soil classification, shoring/sloping techniques and requirements, access requirements, and the hazards of underground work.

If there is any doubt about the safety of an excavation, an engineering opinion shall be obtained before any work starts.

All work in trenches/excavations shall comply with the Construction Safety Orders, Article 6, Excavations.

8.42 Ladders

Ladders shall be maintained in good condition at all times, the joint between the steps and side rails shall be tight, all hardware and fittings securely attached, and the movable parts shall operate freely without binding or undue play.

Metal ladders shall not be used while working on electrical equipment. All metal ladders shall be marked with a sticker or stencil that clearly says: 'Caution–Do Not Use Around Electrical Equipment'.

Supervisors shall periodically inspect ladders for wear and damage. All ladders shall be cleaned of oil, grease, or slippery materials. Ladders which have developed defects shall be withdrawn from service for repair or destruction and tagged or marked as 'Dangerous, Do Not Use'.

8.43 Handling Hazardous Substances

See Chapter D5, the First Responder Operations Reference Manual, and the Maintenance Hazardous Waste Manual for more information on this subject.

8.44 Radioactive Incidents

See Chapter D5 - Spills of Substances on Highway Rights of Way and the First Responder Operations Reference Manual.

8.45 Chemicals

See Chapter C2 - Vegetation Control, and Chapter D5 - Spills of Substances on Highway Rights of Way, for details on this subject.

8.46 Explosives

Care in handling and storing explosives are specified in Chapter 5 - Blasting.

8.47 Use of Reclaimed Water

Before employees use reclaimed water, they shall be told about the potential health hazards involved with contact or accidental ingestion of reclaimed water. They shall also be trained how to properly clean up after using it.

Reclaimed water must meet applicable coliform and health standards before, it can be used by Caltrans personnel, for irrigation, or dust control. The county health department shall be contacted for guidance.

Contact with reclaimed water shall be kept to a minimum. Workers shall use impermeable (rubber) gloves and appropriate protective clothing. Supervisors should contact the local supplier to determine what other specific precautions should be taken.

Employees must have clean water and soap available at the work site when using reclaimed water. Workers shall be instructed to wash their hands thoroughly before eating, drinking, smoking, or going to the bathroom.

More information on the use of reclaimed water is found in the Maintenance Code of Safe

Operating Practices.

Refer to the attached pages for the Standard Plans

APPENDIX T10 - Traffic Control System For Lane Closure on Freeways and Expressways

APPENDIX T10A - Traffic Control System For Lane And Complete Closures on Freeways and Expressways

APPENDIX T11 - Traffic Control System For Lane Closure on Multilane Conventional Highways

APPENDIX T12 - Traffic Control System For Lane Closure on Multilane Conventional Highways

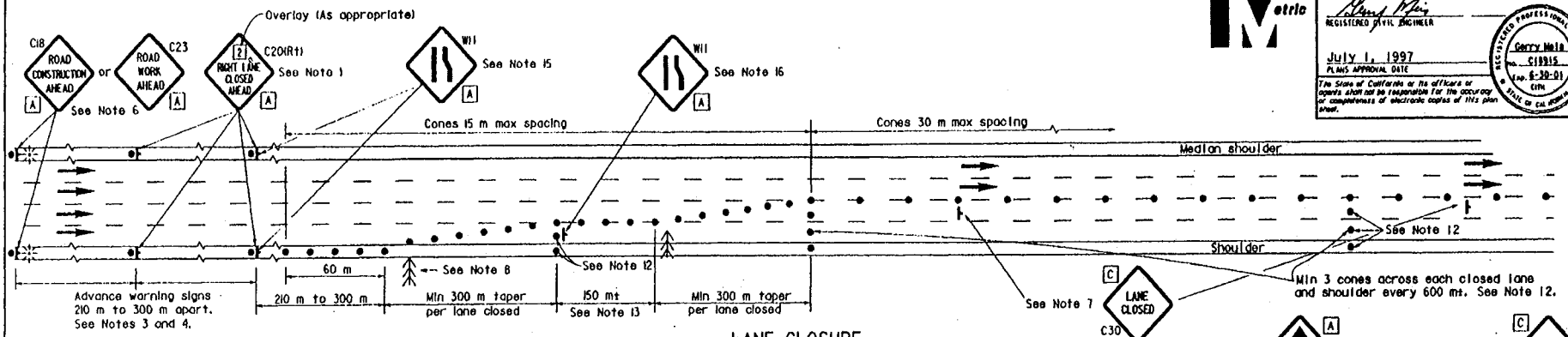
APPENDIX T13 - Traffic Control System For Lane Closure on Two Lane Conventional Highways

APPENDIX T14 - Traffic Control System For Ramp Closures

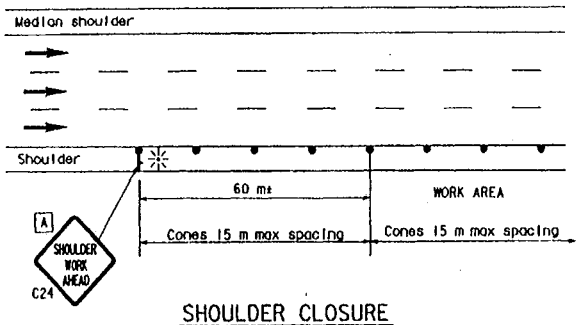
APPENDIX T15 - Traffic Control System For Moving Lane Closure on Multilane Highways

APPENDIX T16 - Traffic Control System For Moving Lane Closure on Multilane Highways

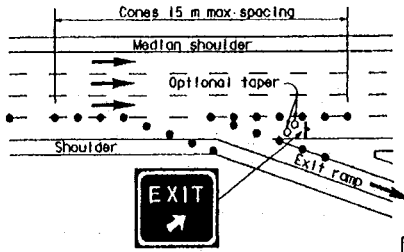
APPENDIX T17 - Traffic Control System For Moving Lane Closure on Two Lane Highways



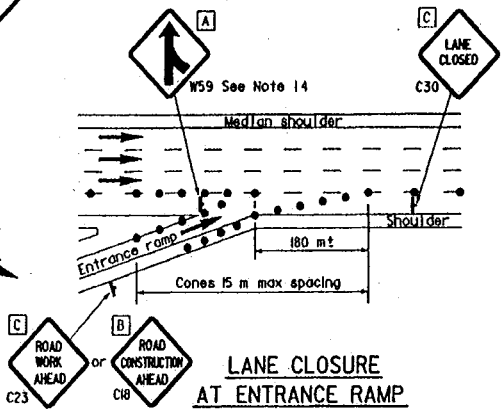
LANE CLOSURE



SHOULDER CLOSURE



LANE CLOSURE AT EXIT RAMP



LANE CLOSURE AT ENTRANCE RAMP

NOTES

1. Median lane closures shall conform to the details for outside lane closures except that C20 (Lt) signs shall be used.
2. Not less than one person shall be assigned to full time maintenance of traffic control devices on all night lane closures or day-time closures exceeding 1.6 km in length, including taper.
3. Duplicate sign installations are not required:
   a) On opposite shoulder if at least one-half of the available lanes remain open to traffic.
   b) In the median if the width of the median shoulder is less than 2.4 m and the outside lanes are to be closed.
4. All advance warning sign installations shall be equipped with flags for daytime closures. Flashing beacons shall be placed at the locations indicated during night lane closure.
5. A C13 "END CONSTRUCTION" or C14 "END ROAD WORK" sign, as appropriate, shall be placed at the end of the lane closure unless the end of work area is obvious or ends within a larger project's limits.
6. If the C18 (or C23) sign would follow within 600 m of a stationary C18, C23 or C11 "STATE HIGHWAY CONSTRUCTION NEXT_____ MILES", use a C20 sign for the first advance warning sign.
7. Place a C30 sign every 600 m throughout length of lane closure.
8. One flashing arrow sign for each lane closed. The first flashing arrow sign shall be Type I. All others may be either Type I or Type II.
9. A minimum 450 m of sight distance shall be provided where possible for vehicles approaching the first flashing arrow sign. Lane closures shall not begin at top of crest vertical curve or on a horizontal curve.
10. All cones used for night lane closures shall be fitted with reflective sleeves as specified in the specifications.
11. Portable delineators, placed at one-half the spacing indicated for traffic cones may be used in lieu of cones for daytime closures only.
12. Unless otherwise specified in the special provisions, a minimum of 3 cones shall be placed transversely across each closed lane and shoulder at each location where a taper across a traffic lane ends and every 600 m as shown on the "Lane Closure" detail. Two Type II barricades may be used instead of the 3 cones. The transverse alignment of the cones or barricades on the closed shoulder may be shifted from the transverse alignment to provide access to the work.
13. Unless otherwise specified in the special provisions, the 150 m section of the lane closure shown along lanelines shall be used between the 300 m lane closure tapers when two or more adjacent traffic lanes are to be closed.
14. Unless otherwise specified in the special provisions, the C84 and W59 signs shall be used as shown.
15. Where specified in the special provisions, a W11 "LANE REDUCTION SYMBOL" sign is to be used in place of the C20 "RIGHT LANE CLOSED AHEAD" sign.
16. The W11 "LANE REDUCTION SYMBOL" sign shown at this location is to be used where the W11 sign is used as advance warning as described in Note 15.

SIGN PANEL SIZE (Min)

A	1200 mm x 1200 mm
B	900 mm x 900 mm
C	750 mm x 750 mm

LEGEND

- ● Traffic Cone
- O Traffic Cone (optional taper)
- Portable Sign
- Flashing Arrow Sign
- Direction of Travel
- Portable Flashing Beacon

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

TRAFFIC CONTROL SYSTEM FOR LANE CLOSURE ON FREEWAYS AND EXPRESSWAYS

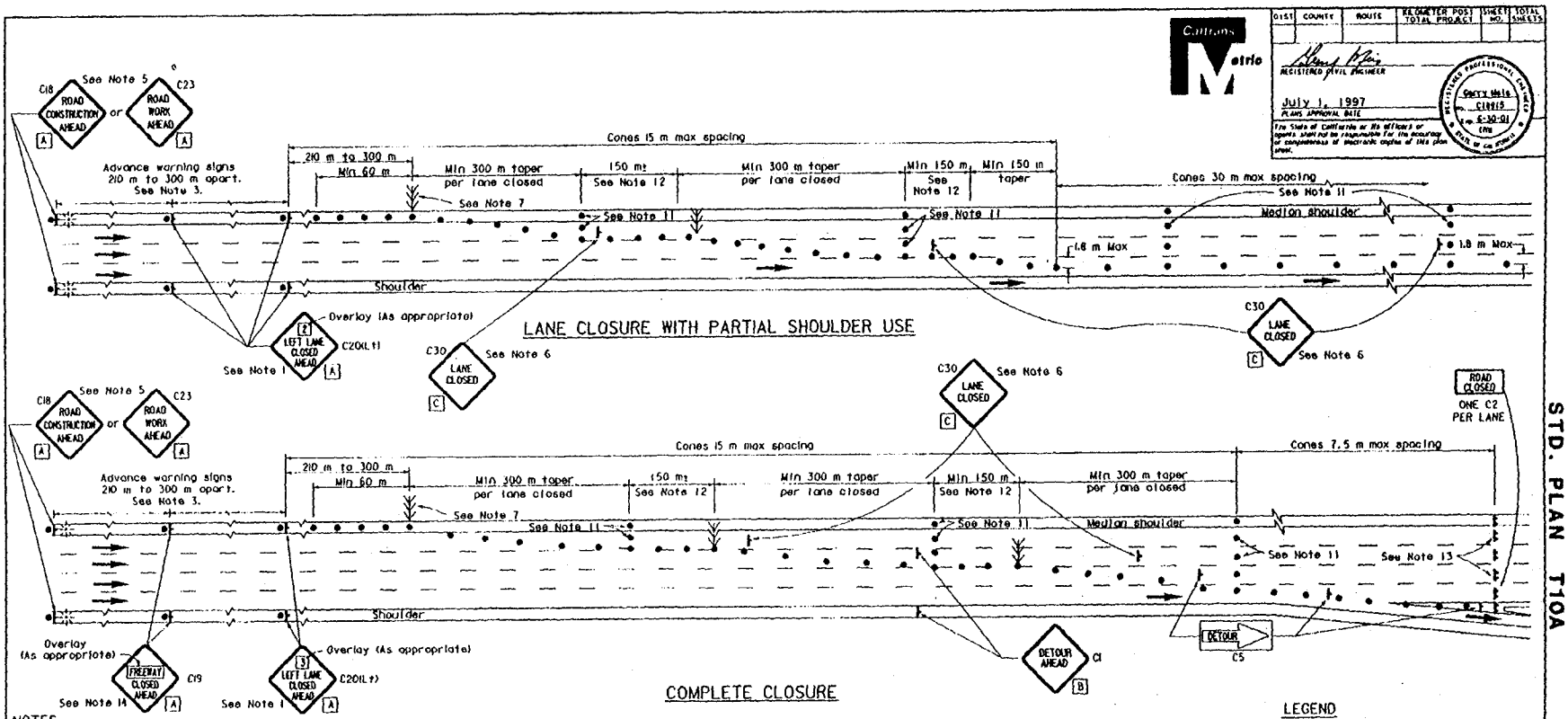
NO SCALE

T10

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET NO.	TOTAL SHEETS

REGISTERED CIVIL ENGINEER
July 1, 1997
PLANS APPROVAL DATE
The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.
REGISTERED PROFESSIONAL ENGINEER — Gerry Mola — No. C18915 — Exp. 6-30-01 — CIVIL — STATE OF CALIFORNIA

STD. PLAN T10



DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET NO.	TOTAL SHEETS

REGISTERED CIVIL ENGINEER

July 1, 1997
PLANS APPROVAL DATE

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REGISTERED PROFESSIONAL ENGINEER Gary Wells No. C18915 Exp. 6-30-01 CIVIL STATE OF CALIFORNIA

NOTES

1. Lane closures on the right side using partial median shoulder as a traffic lane shall conform to the details for inside lane closure except that C20(Rt) signs shall be used.
2. Not less than one person shall be assigned to full time maintenance of traffic control devices on all complete closures, on all night lane closures, and daytime closures exceeding 1.6 km in length, including taper.
3. All advance warning sign installations shall be equipped with flags for daytime closure. Flashing beacons shall be placed at the locations indicated during night lane closures.
4. A C13 "END CONSTRUCTION" or C14 "END ROAD WORK" sign, as appropriate, shall be placed at the end of the lane closure unless the end of work area is obvious or ends within a larger project's limits.
5. If the C18 (or C23) sign would follow within 600 m of a stationary C18, C23 or C11 "STATE HIGHWAY CONSTRUCTION NEXT ___ MILES" use a C20 sign for the first advance warning sign.
6. Place a C30 sign every 600 m throughout length of lane closure.
7. One flashing arrow sign for each lane closed. The first flashing arrow sign shall be Type L All others may be either Type I or Type II.
8. A minimum 450 m of sight distance shall be provided where possible for vehicles approaching the first flashing arrow sign. Lane closures shall not begin at the top of crest vertical curve or on a horizontal curve.
9. All cones used for night lane closures shall be fitted with reflective sleeves as specified in the specifications.
10. Portable delineators, placed at one-half the spacing indicated for traffic cones, may be used in lieu of cones for daytime closures only.
11. Unless otherwise specified in the special provisions, a minimum of 3 cones shall be placed transversely across each closed lane and shoulder at each location where a taper across a traffic lane ends and every 600 m as shown on the "Lane Closure With Partial Shoulder Use" detail. Two Type II barricades may be used instead of the 3 cones. The transverse alignment of the cones or barricades on the closed shoulder may be shifted from the transverse alignment to provide access to the work.
12. Unless otherwise specified in the special provisions, the 150 m section of the lane closure shown along lanelines shall be used between the 300 m lane closure tapers when two or more adjacent traffic lanes are to be closed.
13. A minimum of Two Type II barricades shall be placed across each closed lane and shoulder at the location shown and every 600 m within the complete closure area. Within the complete closure area, the transverse alignment of the barricades on the closed shoulder may be shifted from the transverse alignment to provide access to the work.
14. Where specified in the special provisions, a C1 "DETOUR AHEAD" sign is to be used in place of the C19 "FREEWAY CLOSED AHEAD" sign.

SIGN PANEL SIZE (Min)

A	1200 mm x 1200 mm
B	900 mm x 900 mm
C	750 mm x 750 mm

LEGEND

- Traffic Cone
- Portable Sign
- Flashing Arrow Sign
- Direction of Travel
- Portable Flashing Beacon

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

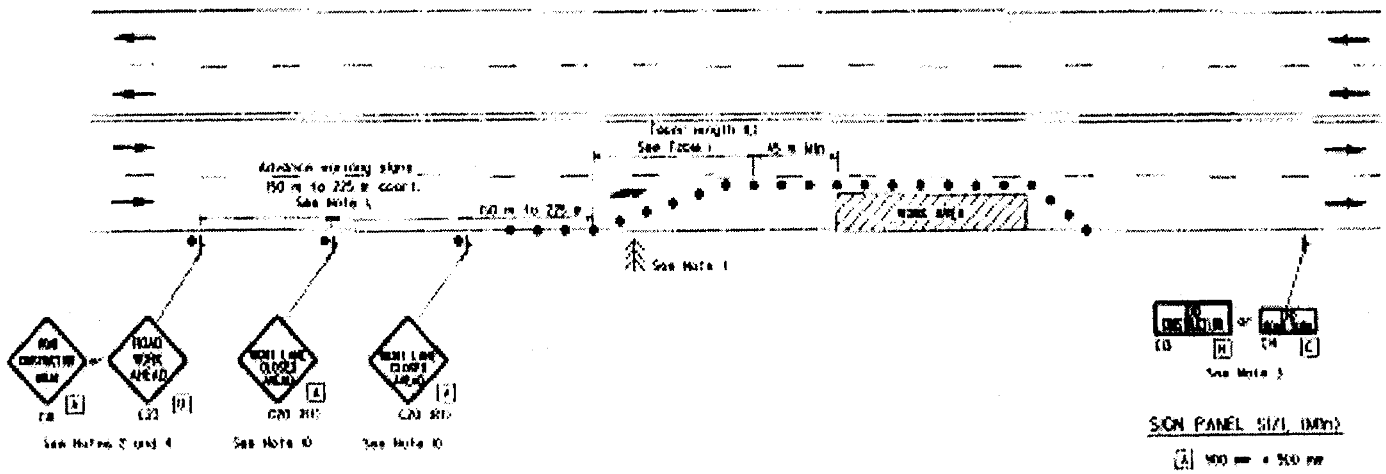
TRAFFIC CONTROL SYSTEM FOR LANE AND COMPLETE CLOSURES ON FREEWAYS AND EXPRESSWAYS

NO SCALE

T10A

STD. PLAN T10A

TYPICAL LANE CLOSURE



SIGN PANEL SIZE (Min)

- [A] 900 mm x 900 mm
- [B] 1200 mm x 450 mm
- [C] 900 mm x 450 mm
- [Z] 750 mm x 750 mm

LEGEND

- Traffic cone
- Portable Sign
- Direction of Travel
- Flashing Arrow Sign

NOTES

1. [illegible]
2. [illegible]
3. [illegible] "ROAD CONSTRUCTION" or C4 "END ROAD WORK" signs, as appropriate, shall be placed at the end of the lane closure [illegible]
4. If the C18 (or C23) sign would [illegible] C18, C23, or C11 "STATE HIGHWAY CONSTRUCTION NEXT ____ MILES", use a C20 sign for the first advance warning sign.
5. All cones used for night lane closures shall be fitted with reflective sleeves as specified in the specifications.
6. Portable delineators, placed at [illegible] spacing [illegible] for traffic cones, may be used in lieu of cones for daytime closures only.
7. Flashing arrow sign shall be either Type I or Type II.
8. The maximum spacing between cones in a taper shall be approximately as shown in Table 1 and [illegible] m maximum spacing on tangent.
9. For approach speeds over 80 km/h, use the "Traffic Control System for Lane Closure On Freeways and Expressways" plan for lane closure details and requirements.
10. Where specified in the special provisions, a W11 "LANE REDUCTION SYMBOL" sign is to be used in place of the C20 "RIGHT LANE CLOSED AHEAD" sign.

TABLE 1

Approach Speed (km/h)	A Taper Length (L) (m)*	B Number of Cones for Taper	Spacing of Cones Along Taper (m)*
[illegible]	[illegible]	[illegible]	7.5
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
Over 80	See Note 9		

* Based on 3.6 m wide lane. This column is also appropriate for lane widths less than 3.6 m.

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

TRAFFIC CONTROL SYSTEM FOR LANE CLOSURE ON MULTILANE CONVENTIONAL HIGHWAYS

NO SCALE

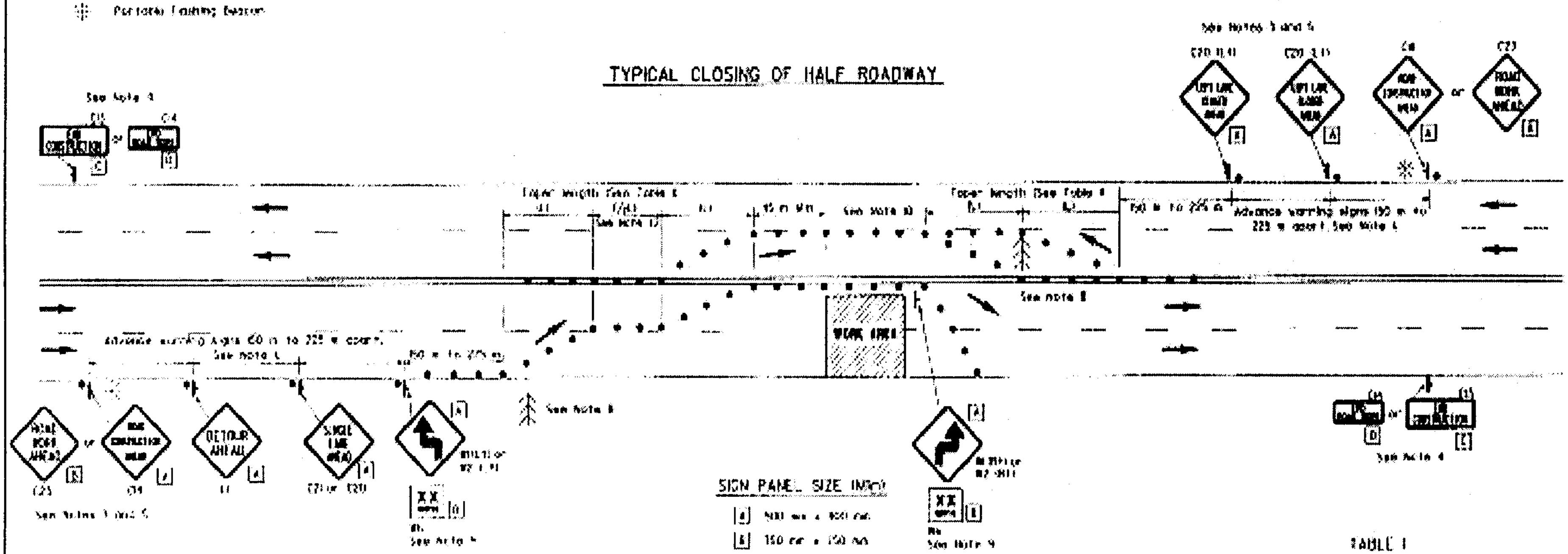
T11

July 1, 1991

LEGEND

- Traffic Cone
- Portable Sign
- Flashing Arrow Sign
- Direction of Travel
- Portable Flashing Beacon

TYPICAL CLOSING OF HALF ROADWAY



SIGN PANEL SIZE (Min)

- [A] 900 mm x 900 mm
- [B] 750 mm x 750 mm
- [D] 900 mm x 450 mm
- [E] 1200 mm x 450 mm

NOTES

1. [illegible]
2. [illegible]
3. [illegible]
4. [illegible]
5. [illegible]
6. [illegible]
7. [illegible]
8. Flashing arrow signs shall be either Type [illegible]
9. [illegible]
10. [illegible]
11. [illegible]
12. [illegible]

TABLE 1

Approach Speed (km/h)	* Taper Length (L) (m)	* Number of Cones for Taper	Spacing of Cones along Taper (m)
0-40	38	6	7.5
40-65	98	9	12
65-80	183	13	15
Over 80	See Note 11		

* Based on 3.6 m wide lane. This column is also appropriate for lane widths less than 3.6 m.

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

TRAFFIC CONTROL SYSTEM FOR LANE CLOSURE ON MULTILANE CONVENTIONAL HIGHWAYS

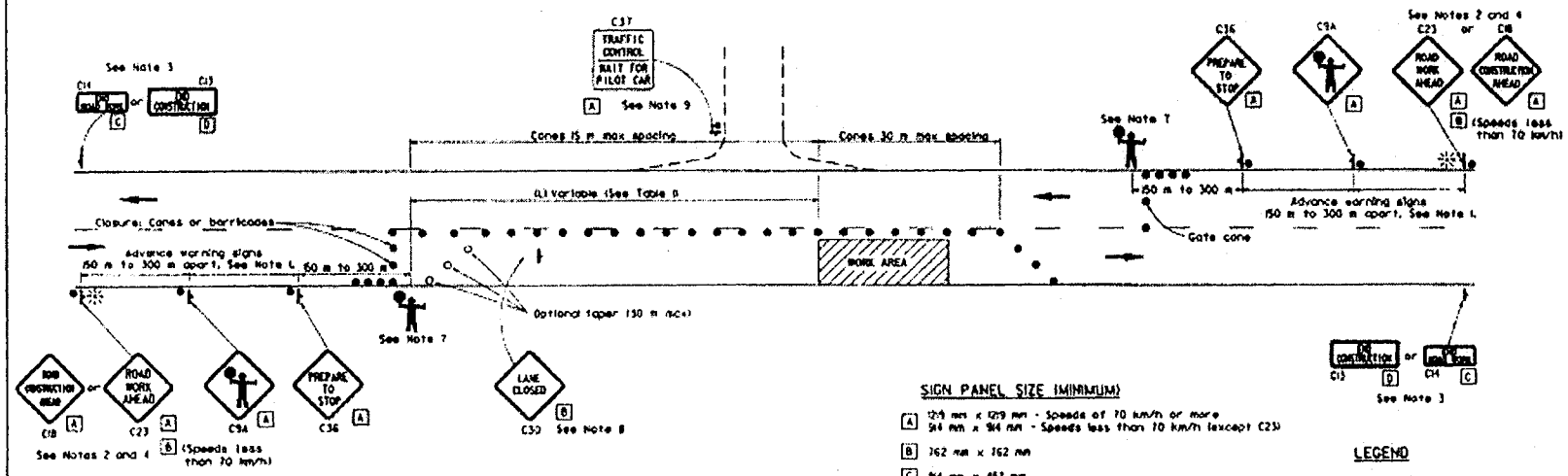
NO SCALE

T12

Metric

July 1, 1999

TYPICAL LANE CLOSURE WITH REVERSIBLE CONTROL



SIGN PANEL SIZE (MINIMUM)

- A 1219 mm x 1219 mm - Speeds of 70 km/h or more; 914 mm x 914 mm - Speeds less than 70 km/h (except C23)
- B 762 mm x 762 mm
- C 914 mm x 457 mm
- D 1219 mm x 457 mm

TABLE 1

Approach Speed km/h	L (1) (min)
0-50	60
50-70	90
over 70	150

* Increase by 20 percent on sustained downgrades steeper than 3 percent and longer than 1.5 km.

LEGEND

- Traffic Cone
- Traffic Cone (optional taper)
- Portable Sign
- Direction of Travel
- Portable Flashing Beacon
- Flagger

NOTES

1. Where approach speeds are low, signs may be placed at 90 m spacing, and in urban areas, closer.
2. All advance warning sign installations shall be equipped with flags for daytime closures. Flashing beacons shall be placed at the locations indicated during night lane closures.
3. A C13 "END CONSTRUCTION" or C14 "END ROAD WORK" sign, as appropriate, shall be placed at the end of the lane control unless the end of work area is obvious, or ends within a longer project's limits.
4. If the C18 (or C23) sign would follow within 600 m of a stationary C18, C23, or C11 "STATE HIGHWAY CONSTRUCTION NEXT _____ MILES", use a C9A sign for the first advance warning sign.
5. All cones used for night lane closures shall be fitted with reflective sleeves as specified in the specifications.
6. Portable delineators, placed at one-half the spacing indicated for traffic cones, may be used in lieu of cones for daytime closures only.
7. Additional advance flaggers may be required. Flagger should stand in a conspicuous place, be visible to approaching traffic as well as approaching vehicles after the first vehicle has stopped. Nighttime flagger station shall be illuminated as provided in the current edition of the "Manual of Traffic Controls" published by the State of California, Department of Transportation. Place a minimum of four cones at 15 m intervals in advance of flagger station as shown.
8. Place C30 "LANE CLOSED" sign at 150 to 300 m intervals throughout extended work areas. They are optional if the work area is visible from the flagger station.
9. When a pilot car is used, place a C37 "TRAFFIC CONTROL-WAIT FOR PILOT CAR" sign at all intersections within traffic control area. Signs shall be clean and visible at all times.

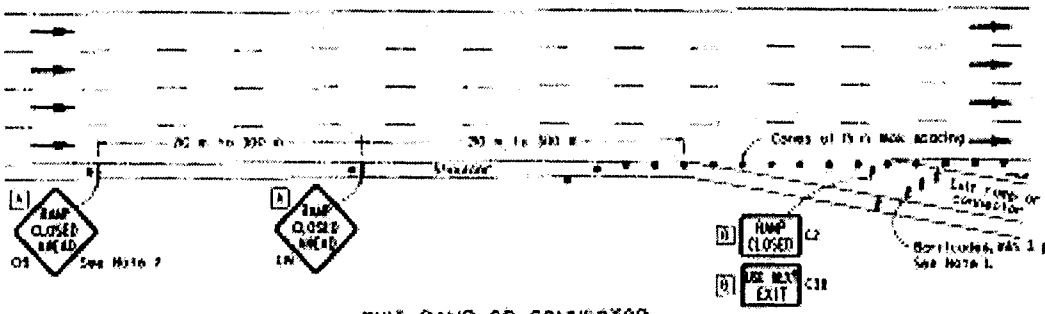
STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

TRAFFIC CONTROL SYSTEM FOR LANE CLOSURE ON TWO LANE CONVENTIONAL HIGHWAYS

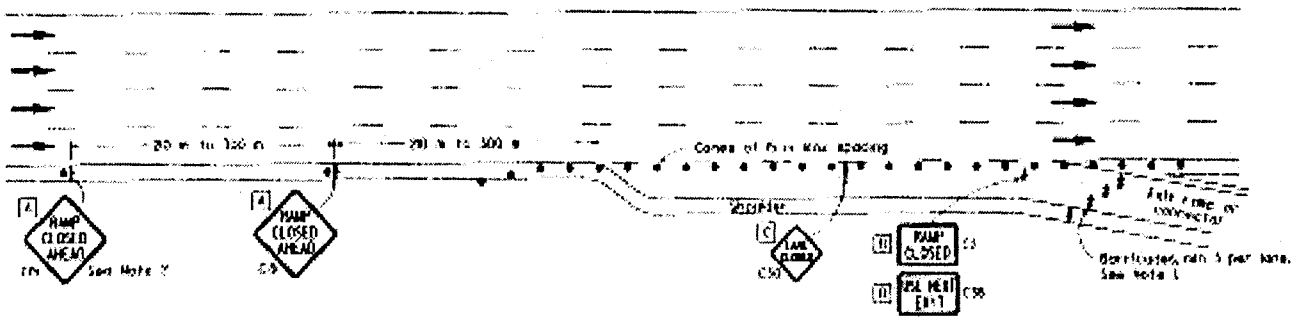
NO SCALE

T13

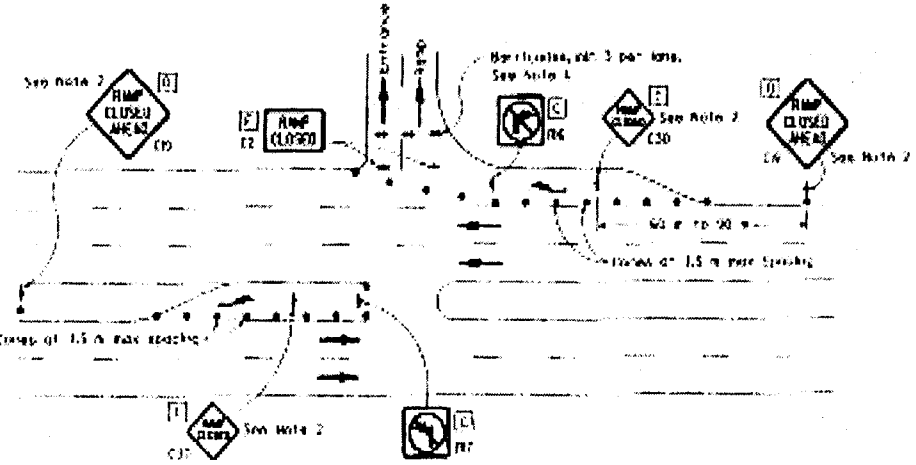
TYPICAL RAMP CLOSURES



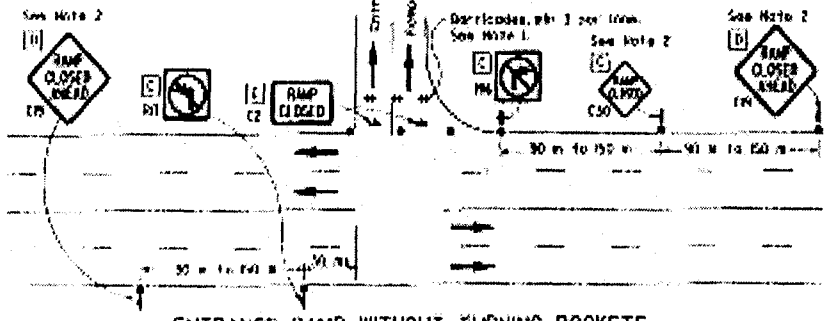
EXIT RAMP OR CONNECTOR



EXIT RAMP OR CONNECTOR WITH ADDITIONAL LANE



ENTRANCE RAMP WITH TURNING POCKETS



ENTRANCE RAMP WITHOUT TURNING POCKETS

NOTES

1. Barricades shall be Type I, II, or III for closures lasting one week or less and Type II for closures lasting longer than one week.
2. In lieu of placing the (9) "RAMP CLOSED AHEAD" and (10) "RAMP CLOSED" signs, black on orange overlay plates with the word "CLOSED" may be mounted, as directed by the Engineer, on all guide signs that refer to the closed ramp. The letter size on the overlay shall be the same as the guide sign.
3. All advance warning sign installations shall be equipped with flags for daytime closures.
4. All cones used for night time closures shall be fitted with reflective sleeves as specified in the specifications.
5. Portable delineators, placed at one-half the spacing indicated for traffic cones, may be used in lieu of cones for daytime cone closures only.
6. During nighttime ramp closures, at least one person shall be assigned full time for maintenance of traffic control devices.

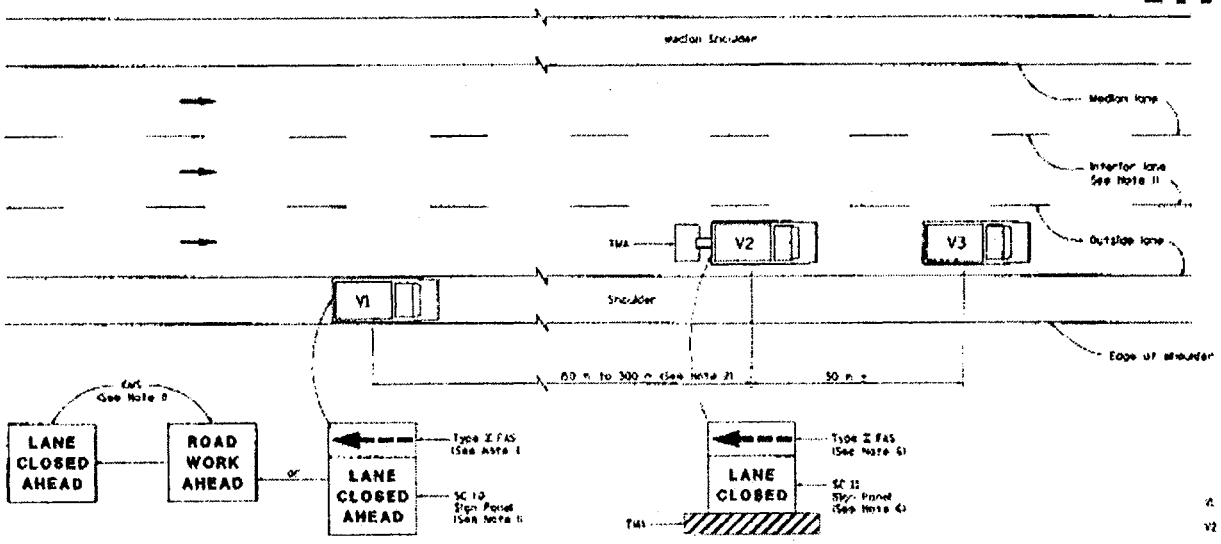
LEGEND	SIGN PANEL SIZE (MIN)
● Traffic Cone	A 900 mm x 1200 mm
▮ Sign	B 600 mm x 750 mm
▮ Barricades	C 750 mm x 750 mm
⟶ Direction of Travel	D 900 mm x 900 mm
⟶ Turn Arrow	E 900 mm x 600 mm

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

TRAFFIC CONTROL SYSTEM FOR RAMP CLOSURE

NO SCALE

T14



MOVING LANE CLOSURE ON MEDIAN OR OUTSIDE LANE OF MULTILANE HIGHWAYS

LEGEND

V1	Sign Vehicle
V2	Shadow Vehicle
V3	Barrel Application Vehicle
FAS	Flashing Arrow Sign
CMS	Changeable Message Sign
TMA	Truck-Mounted Attenuator
→	Direction of Travel

NOTES

1. Either the SC 10 sign panel shown or a changeable message sign shall be mounted on the rear of sign vehicle V1. A Type X flashing arrow sign shall be mounted on the rear of sign vehicle V1 and used with the SC 10 sign panel. A Type X flashing arrow sign will not be required with the changeable message sign provided the flashing arrow sign symbol may be displayed on the changeable message sign board. The changeable message sign shall be sequenced to show the "ROAD WORK AHEAD" message first, followed by the "LANE CLOSED AHEAD" message and then the flashing arrow sign symbol. For median lane closure, the flashing arrow sign symbol shall be reversed with the arrowhead on the right.

2. If traffic queues develop, sign vehicle V1 should be positioned upstream from the end of queue. Sign vehicle V1 shall be positioned where highly visible when shoulders are not available.

3. A minimum sight distance of 450 m. should be provided in advance of sign vehicle V1.

4. Sign vehicle V1 should remain at the beginning of horizontal or vertical curves until the other vehicles (V2 and V3) are far enough beyond the curve to assure the minimum sight distance of 450 m.

5. Vehicle-mounted sign panels shall be Type IX or XI reflective sheeting, black on white or black on orange with 150 mm minimum series D letters per Caltrans sign specifications.

6. Cross Vehicle weight of shadow vehicle V2 shall be a minimum of 9000 kilograms and shall be equipped with a truck-mounted attenuator (TMA), the sign panel shown and a Type II flashing arrow sign shall be mounted on the rear of shadow vehicle V2. For median lane closure the flashing arrow sign symbol shall be reversed with the arrowhead on the right.

7. All vehicles used for lane closures shall be equipped with two-way radios and the vehicle operators shall maintain communication during the work or application operation.

8. All vehicles shall be equipped with flashing or rotating amber lights.

9. Where sufficient shoulder width is not available, sign vehicle V1 may encroach into the traffic lane, staying as close to the edge of shoulder as practicable. When operating in this mode both V1 and V2 shall be equipped with a truck-mounted attenuator (TMA) and the gross vehicle weight of V1 and V2 shall be a minimum of 9000 kilograms each.

10. Where workers would be on foot in the work area, a stationary type lane closure (Standard Plan T10, T11 etc., as applicable) shall be used instead of this plan.

11. For moving lane closure on interior lane or multilane highways, see Standard Plan T16.

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

TRAFFIC CONTROL SYSTEM FOR MOVING LANE CLOSURE ON MULTILANE HIGHWAYS

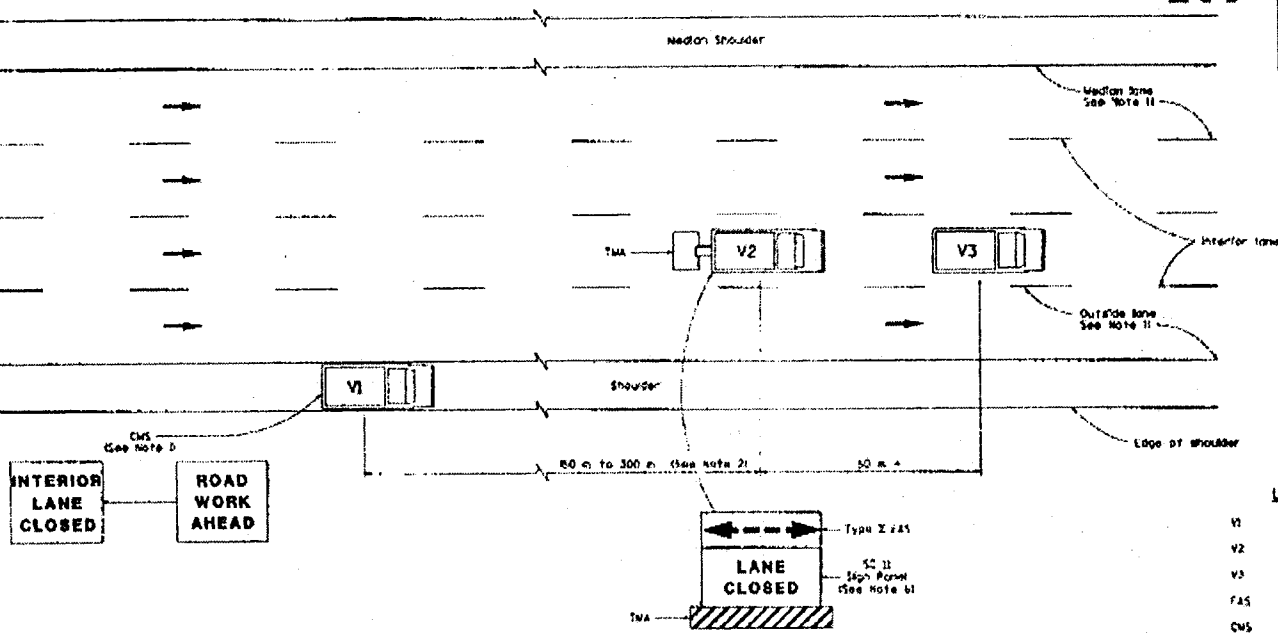
NO SCALE

ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE SHOWN

T15

July 1, 1999

1999 STD. PLAN T15



MOVING LANE CLOSURE ON INTERIOR LANE OF MULTILANE HIGHWAYS

LEGEND

V1	Sign Vehicle
V2	Shadow Vehicle
V3	Work/Application Vehicle
FAS	Flashing Arrow Sign
CMS	Changeable Message Sign
TMA	Truck-Mounted Attenuator
→	Direction of Travel

NOTES

1. A changeable message sign shall be mounted on the rear of sign vehicle V1. The changeable message sign shall be sequenced to show the "ROAD WORK AHEAD" message first, followed by the "INTERIOR LANE CLOSED" message. The message "CENTER LANE CLOSED" may be used in place of the "INTERIOR LANE CLOSED" message.
2. If traffic queues develop, sign vehicle V1 should be positioned upstream from the end of queue. Sign vehicle V1 shall be positioned where highway visible when shoulders are not available.
3. A minimum sight distance of 450 m should be provided in advance of sign vehicle V1.
4. Sign vehicle V1 should remain at the beginning of horizontal or vertical curves until the other vehicles (V2 and V3) are far enough beyond the curve to restore the minimum sight distance of 450 m.
5. Vehicle-mounted sign panels shall be Type III or IX reflective sheeting (black on white or black on orange) with 60 mm minimum series D letters per Caltrans sign specifications.
6. Gross vehicle weight of shadow vehicle V2 shall be a minimum of 3600 kilograms and shall be equipped with a truck-mounted attenuator (TMA). The sign panel shown and a Type IX flashing arrow sign shall be mounted on the rear of shadow vehicle V2. For median lane closure the flashing arrow sign symbol shall be reversed with the arrowhead on the right.
7. All vehicles used for lane closures shall be equipped with two-way radios and the vehicle operators shall maintain communication during the work or application operation.
8. All vehicles shall be equipped with flashing or rotating amber lights.
9. Where sufficient shoulder width is not available, sign vehicle V1 may encroach into the traffic lane staying as close to the edge of shoulder as practicable. When operating in this mode both V1 and V2 shall be equipped with a truck-mounted attenuator (TMA) and the gross vehicle weight of V1 and V2 shall be a minimum of 3600 kilograms each.
10. Where workers would be on foot in the work area, a stationary type lane closure (Standard Plan T.C. 11 etc., as applicable) shall be used instead of this plan.
11. For moving lane closure on median or outside lanes of multilane highways, see Standard Plan T15.

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

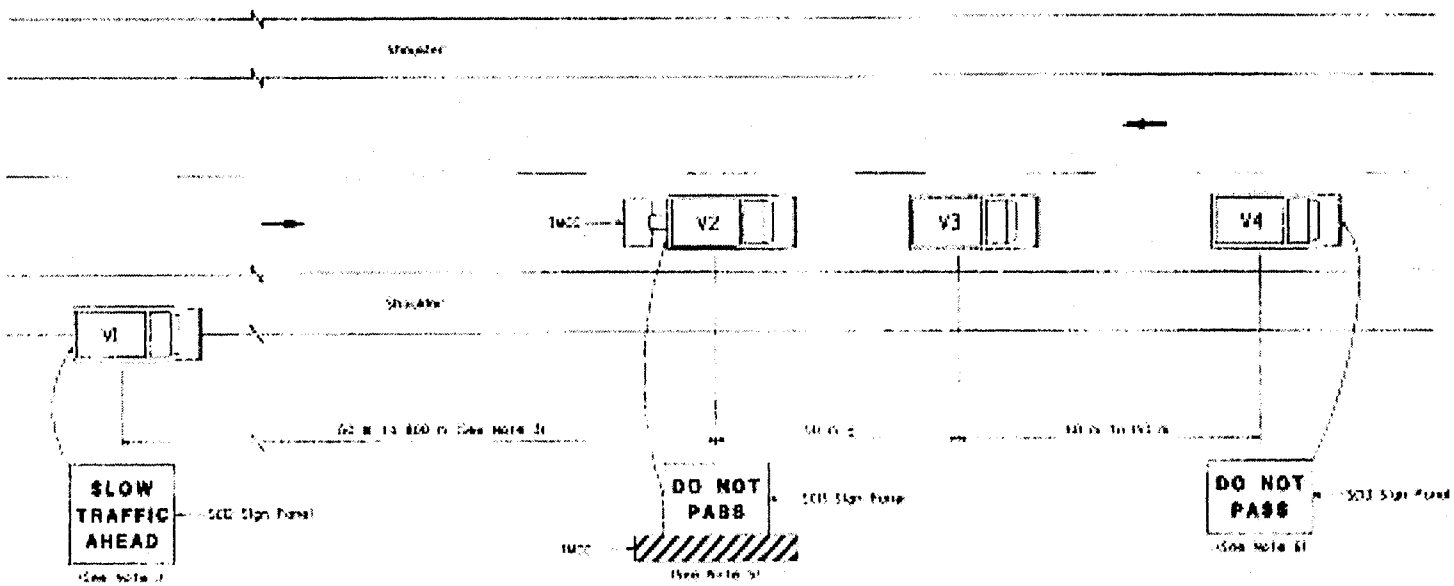
TRAFFIC CONTROL SYSTEM FOR MOVING LANE CLOSURE ON MULTILANE HIGHWAYS

NO SCALE

ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE SHOWN

T16

1999 STD. PLAN T16



NOTES

1. Either the sign panel shown or a changeable message sign which can display the "SLOW TRAFFIC AHEAD" message shall be mounted on the rear of sign vehicle V1.

2. Sign vehicle V1 should be positioned where nearby trailer when shoulders are not available.

3. If traffic queues develop, sign vehicle V1 should be positioned upstream from the end of queue.

4. Vehicle-mounted sign panels shall be Type II or IX reflective sheeting black on white or black on orange with fluorescent surface D letters per California sign specifications.

5. Vehicle vehicle V2 shall weigh between 5000 and 6000 kilograms and shall be equipped with a truck-mounted crash cushion. The sign panel shown shall be mounted on the rear of shadow vehicle V2. The message "LANE CLOSED" may be used in place of the "DO NOT PASS" message.

6. The sign panel shown shall be mounted on the front of sign vehicle #4, facing oncoming traffic. The message "CAUTION" may be used in place of the "DO NOT PASS" message.

7. All vehicles shall be equipped with flashing or rotating amber lights.

8. Sign vehicle #4 shall not be required when the work and vehicles V2 and V3 are 305 m or more from the centerline of the highway during the work or application operations.

9. All vehicles used for lane closures shall be equipped with two way radios and the vehicle operators shall maintain communication during the work or application operation.

10. Only one shall not be used where workers would be on foot in the work area. Use a stationary type lane closure (Standard Plan T10) for this condition.

LEGEND

V1	Sign Vehicle
V2	Shadow Vehicle
V3	Work/Application Vehicle
V4	Sign Vehicle
TMCC	Truck-Mounted Crash Cushion
→	Direction of Travel

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

TRAFFIC CONTROL SYSTEM FOR MOVING LANE CLOSURE ON TWO LANE HIGHWAYS

NO SCALE

T17

Appendix E-1/E-2

Constituents to Monitor for Each BMP Type
Observation/Monitoring Activities Required per BMP Type

Appendix E-1. Constituents to Monitor per BMP Type (D7) [1,2]

Analyte	Drain Inlet Inserts[3]	Extended Detention Basins[4]	Infiltration Basins[5]	Infiltration Trench[6]	Biolfiltration Swales/strips[7]	Continuous Deflective Separation (CDS) Units	Media Filters[8]	Oil/Water Separators[9]	MCTTs[10]
Sampling frequency	4/yr	5/yr 2/yr grab	2/yr for groundwater samples 1/yr for sediment samples	2/yr	4/yr	4/yr	4/yr 2/yrgrab	8/2 yr oil and grease, grab 2/yr for TPH-gasoline; TPH-diesel, TPH-oil, grab	4/yr 2/yr grab
Conventionals									
pH	Effluent	Influent and effluent	Groundwater	Groundwater	Influent and effluent	Influent and effluent	Influent and effluent	Influent and effluent	Influent and effluent
Specific conductance	Effluent	Influent and effluent	Groundwater	Groundwater	Influent and effluent	Influent and effluent	Influent and effluent	Influent and effluent	Influent and effluent
Hardness	Effluent	Influent and effluent	Groundwater	Groundwater	Influent and effluent	Influent and effluent	Influent and effluent	Influent and effluent	Influent and effluent
TSS	Effluent	Influent and effluent	None	None	Influent and effluent	Influent and effluent	Influent and effluent	None	Influent and effluent
Nutrients									
Nitrate-nitrogen	Effluent	Influent and effluent	Ground water (well only)	None	Influent and effluent	Influent and effluent	Influent and effluent	None	Influent and effluent
Total Kjedahl nitrogen	Effluent	Influent and effluent	Ground water (well only)	None	Influent and effluent	Influent and effluent	Influent and effluent	None	Influent and effluent
Total phosphorous	Effluent	Influent and effluent	Ground water (well only)	None	Influent and effluent	Influent and effluent	Influent and effluent	None	Influent and effluent
Total and Dissolved Metals									
Copper	Effluent, inserts	Influent and effluent	Ground water (well only), sediment and soils	Groundwater	Influent and effluent	Influent and effluent	Influent and effluent	None	Influent and effluent
Lead	Effluent, inserts	Influent and effluent	Ground water (well only), sediment and soils	Groundwater	Influent and effluent	Influent and effluent	Influent and effluent	None	Influent and effluent
Zinc	Effluent, inserts	Influent and effluent	Ground water (well only), sediment and soils[11]	Groundwater	None	Influent and effluent	Influent and effluent	None	Influent and effluent

Analyte	Drain Inlet Inserts[3]	Extended Detention Basins[4]	Infiltration Basins[5]	Infiltration Trench[6]	Biolfiltration Swales/strips[7]	Continuous Deflective Separation (CDS) Units	Media Filters[8]	Oil/Water Separators[9]	MCTTs[10]
Organics[12]									
TPH-gasoline; TPH-diesel; TPH-oil	Effluent, inserts	Influent and effluent	Groundwater (well only) sediment and soils)	None	Influent and effluent	Influent and effluent	Influent and effluent	Influent and effluent	Influent and effluent
Oil and grease	None	None	None	None	None	None	None	None	None
Bacteria[11]									
Fecal coliform	None	Influent and effluent	Groundwater (well only)	None	Influent and effluent	Influent and effluent	Influent and effluent	None	Influent and effluent

1. Appendix E-2 contains other monitoring requirements.
2. At the end of the monitoring period, sediment that has been retained by any of the BMPs will be collected and analyzed to determine the proper disposal methods. The sediment analyses listed here refer to analyses that are required to be run on sediment during normal monitoring.
3. The effluent and in the insert itself will be monitored. Constituent removal efficiency of BMP by extracting sediments metals, and hydrocarbons from the inserts. Using a mass balance approach, the influent will be estimated.
4. Monitoring will take place at both the influent and effluent, using flow-weighted composite samplers, to estimate constituent removal.
5. The groundwater zone sampled will depend on the depth of the groundwater to the basin floor. Generally, for depths less than 10 meters, samples will be collected from the saturated zone via groundwater well and for depths greater than 10 meters, samples will be collected from the vadose zone via a pressure vacuum lysimeter. In addition, samples will be collected two times each year, in December and February. Analytes to be monitored appear here for only those sites monitored via well. Sites monitored via lysimeter will only be analyzed for dissolved copper, lead and zinc.
6. Water quality samples will be taken from the vadose zone via a lysimeter. Only dissolved constituents can be monitored. Samples will be collected only two times each year, in December and February, as for the infiltration basins.
7. Both influent and effluent will be monitored to determine constituent removal. Influent will be sampled at the inlet or as runoff from the highway in the vicinity of the biofilter site.
8. Both the inlet and outlet of the media filter will be monitored to determine constituent removal.
9. Performance will be evaluated by comparing hydrocarbons entering and leaving the device.
10. Constituent removal will be determined by comparing influent and effluent water quality.
11. Core samples will be collected to estimate the rate at which constituents accumulate in the subsurface. These soil samples will be collected from depths of 0.3 m, 0.6 m (1 and 2 feet) in the infiltration basin and analyzed for metals and TPH. Immediately after construction soils will be sampled as above to establish a baseline.
12. To be collected by grab method, except in the case of catch basin inserts and infiltration basins.

Appendix E.2 Observation/Monitoring Activities Required per BMP Type (D7)[1]

DII	**Drain Inlet Insert**
EDB	**Extended Detention Basin**
IB –	**Infiltration Basin**
IT	**Infiltration Trench**
CDS	**Continuous Deflective Separation units**
BF	**Biofiltration Swales/Strips**
MF	**Media filter**
OWE	**Oil/water separator**
MCTT	**Multi-chamber treatment train**

Observation/Monitoring Requirement	**Under Maintenance or Monitoring**	**DII**	**EDB**	**IB**	**IT**	**CDS**	**BF**	**MF**	**OWS**	**MCTT**
Rate of accumulation of material in BMP versus self-cleaning drain inlets.	Monitor									
Examination of sediment at the end of the monitoring period and analyze to determine proper disposal method.	Maintenance		x			x	x	x [2]	x	x
Monthly the sump of the CDS unit needs to be checked to see if it has been filled to 85% capacity. At 85% capacity, the basket should be lifted and all sediment, debris, and litter removed. At the end of the monitoring season, whether the 85% capacity has been reached, the below should occur. Sediment must be sent for analysis to determine proper disposal methods. Littler and debris must be characterized including volume and mass measurements made. At this same time, the little bag downstream of the unit should be examined and its contents characterized.	**??**					**x**				

Observation/Monitoring Requirement	Under Maintenance or Monitoring	DII	EDB	IB	IT	CDS	BF	MF	OWS	MCTT
To understand the service life of the inserts, the media in each of the inserts will be replaced at different intervals based on the cumulative runoff treated, specifically after rainfall depths of 13mm (0.5 in.) 200m (4 in.), and at the end of the rainy season.	Monitoring	**x**								
Vegetation changes over the monitoring period. Standard botanical techniques to record vegetative cover once during each growing season.[3] For areas with poor coverage, ascertain if climate, soils, topographical or other conditions are limiting growth. Proper stabilization techniques will be identified/noted.	Maintenance		x	x			x			
Emergence of wetland characteristics will be noted.	Maintenance		x							
Sediment samples must be collected annually from the surface of the infiltration basin and analyzed for particle size distribution (along with metals and TPH as specified in Appendix E-1.[4]	Monitoring			x						
Rate of stormwater infiltration by using an automated flow meter that will measure changes in water depth in the basin so infiltration can be calculated Data will indicate how the infiltration rate changes over the course of the study and indicate when maintenance is required to removed material that has accumulated on the basin surface.	Maintenance			x						

Observation/Monitoring Requirement	Under Maintenance or Monitoring	DII	EDB	IB	IT	CDS	BF	MF	OWS	MCTT
Rate of accumulation of material in the infiltration basin will be determined by making annual measurements at the end of the rainy season of the depth of the material in the basins.	Maintenance			x						
Core samples will be collected to determine the rate at which constituents are transported into the subsurface. These sol samples will be collected from depths of 0.3 m, 0.6 m, (1 and 2 ft) in the infiltration basin and analyzed for metals and TPH. Immediately after construction soils will be sampled as above for comparison. (Also mentioned in Appendix E-1).	Monitoring			x						
Trench performance: • Trench surface stabilization methods to promote infiltration • Rates of infiltration under typical stormwater runoff conditions • Tendency for clogging	Monitoring				x					
A monitoring well will be constructed to determine the rate of stormwater infiltration into the soils to verify that trenches are draining in the recommended times. Measurements will indicate typical rates of infiltration and how infiltration rates change over time.	Maintenance				**x**					
Hydraulic residence time.[5]	Maintenance						x			

Observation/Monitoring Requirement	Under Maintenance or Monitoring	DII	EDB	IB	IT	CDS	BF	MF	OWS	MCTT
General observation during storm events to ensure device is functioni8ng as designed, and to correct any operational problems that may be occurring and define appropriate operation and maintenance procedures and schedules.	Monitoring	x	x	x	x	x	x	x	x	x

1. Appendix E-1 contains other constituent monitoring requirements.
2. Sediment to be analyzed includes that trapped in the filter and that in the sediment chamber.
3. A reference for standard techniques is Bonham, Charles. *Measurements for Terrestrial Vegetation*, John Wiley and Sons, New York (1989).
4. Metals analyzed for are copper, lead, and zinc
5. Residence time will be calculated using Manning's equation, dye tracing, or similar technique.

Appendix E-3.

Caltrans Statewide Data Management Plan

Technical Memorandum

DOC. No.: CTSW-TM-98-048

TO: Task Order Managers **DATE:** March 5, 1999

California Department of Transportation
Environmental Program – MS 27
Caltrans Consultants
University Affiliates

FROM: Andy Bale **File No.:** 202 (Caltrans)
Larrry Walker Associates 222.11 (LWA)

SUBJECT: Caltrans Stormwater Management Program
1998-99 Data Reporting Protocols

The Caltrans "Statewide Monitoring Data Management Plan" calls for establishment of a Caltrans statewide storm water program database. Data collected as part of this plan will likely be used for a variety of purposes, including:

- compliance with permit reporting requirements,
- establishment of baseline storm water quality from different types of facilities,
- tracking of long-term trends in storm water quality, and
- inputs to load-prediction models and receiving-water impact models.

To aid in development and maintenance of the database, a consistent protocol for reporting water quality data has been established and must be used by all study teams reporting to Caltrans.

This technical memorandum presents the 1998-99 data-reporting protocols that all reporting organizations will be required to follow when reporting water quality data into the Caltrans database. The protocol does not address the reporting of detailed QA/QC information. Reporting organizations are responsible for subjecting the data they report to sufficient QA/QC as detailed in the Caltrans Guidance Manual: Storm water Monitoring Protocols (CTSW-RT-97-19) and in project-specific QA/QC Plans. This protocol addresses only the reporting of water quality-related data. Other Caltrans stormwater studies (e.g. litter, BMP effectiveness, and erosion) will develop their own protocols in coordination with the Caltrans statewide database manager. Contact Mike McCoy (mcmccoy@ucdavis.edu) at the UC Davis Information Center for the Environment (ICE) for details regarding other protocols.

In the Caltrans water quality database, data and information are divided into three data groups:

- Sample Descriptions,
- Sampling Event Descriptions
- Monitoring Site Descriptions

Sample Descriptions contain information specific to each particular sample. This information is specified for each sample reported and generally includes lab results, location, date information, and some QA/QC information. Event Descriptions describe individual sampling events specific to each monitoring site; each monitoring site may have its own set of events during a sampling season, or several sites may share the same event. Site Descriptions contain information about each site in the database. This information generally locates the site, identifies the jurisdiction under which it resides, and specifies physical characteristics of the sites.

Each of these data groups actually represents a separate database, and each database will be related through common fields within the framework of a larger relational database. Samples will be associated with a particular sampling event through the Event ID and with a monitoring site through a Monitoring Site ID. Each event is associated with a monitoring site through a Monitoring Site ID reference. Fields associated with each group are described in the attached Data-Reporting Protocols.

These 1998-99 protocols are a revised version of the 1997-98 protocols. The format and most of the data fields are the same, but several changes and corrections have been made reflecting comments from last year's data reporters. Among the notable changes in the Sample Descriptions database are the use of standard EPA data qualifiers, the elimination of "method detection limit," the use of "minimum detection limit," and new fields for reporting sample start and end times. The Sampling Event Descriptions database has been revised to better describe storm events for purposes of modeling. Among revisions to this database are runoff start and end times, antecedent event rainfall, maximum intensity, and an indication of whether peak flow was captured. Fields describing the individual who collected the samples have been moved from the Sample Descriptions to the Sampling Event Descriptions database. Fields in the Site Descriptions database have remained nearly the same except for the movement of some information into a "BMP Type" field and redefinition of related fields to accommodate BMP data. Also, if you are collecting time series data (flow, precipitation, etc.) please send the data in a separate Excel worksheet for each site and provide the name of the worksheet in the Site Description field "Time Series." Please review these new protocols carefully.

To ensure consistency in the Caltrans storm water database, entries into the requested fields will be as standardized as possible. The entries themselves may be standardized (i.e. only one name is associated with each constituent), or the format may be standardized (e.g. there will be a format by which dates are identified). Standardized entries will facilitate database searches and any future re-structuring of the database. A standard list of entries is provided with the description of each data field. A standard list of constituent names and associated reporting units is provided in Section 4, "Standard Constituent Names." This list is also provided in the attached Excel workbook in the worksheet named "Constituent List."

This memo is being sent to Caltrans project Task Order Managers and all Caltrans staff, consultants, and university affiliates involved in data collection and reporting under Caltrans contracts. A mailing list of Caltrans staff, consultants, and university affiliates is attached. Caltrans Task Order Managers are requested to review the attached mailing list and report to me any corrections to, or omissions from, the list by April 15, 1998.

All Caltrans staff, consultants, and University affiliates who collected data under the 3-Caltrans Storm Water Management Program between November 1, 1998 and April 30, 1999 are required to submit all such data in an electronic Excel file **no later than July 15, 1999.** This deadline is required to comply with the established deadline for the Annual Monitoring Data Summary Report, which will be required under Caltrans' statewide storm water permit. Data entry into the attached Excel workbook template should follow the attached data-reporting protocol. Please note that all future data are required to be reported to Caltrans in the manner described herein.

If you have any questions about the reporting protocols, please call either me or Bob Smith at 530.753.6400. Send electronic Excel workbook files to me at the following email address: andyb@lwadavis.com

MARCH 5, 1999

Caltrans Storm Water Management Program

1998-99 Data-Reporting Protocols

CTSW-TM-98-048

Prepared for:

California Department of Transportation
Environmental Program

GENERAL INSTRUCTIONS

(3/5/99)

- Caltrans will assign the "Monitoring Site ID." All Caltrans data reporters are required to contact the Caltrans database manager at the beginning of each sampling season to receive Monitoring Site IDs for each site they will sample. Data reporters shall provide the database manager with the names of each site to be sampled and the constituents that will be monitored at each site.
- Wherever field entries are hyphenated, include no blanks (e.g. report "Post Mile" as 10-24.3 not as 10 -24.3).
    - When reporting "Constituent", use the names exactly as they appear in the constituent list and use the associated units. Units must be reported as specified (e.g. special characters like, "µ," are not acceptable).
- Use entries from standard lists where they are indicated. If you intend to make any other entry, please contact Caltrans.
- Data fields that are "not applicable" should be left blank. Data fields for which data is considered "unavailable" should be filled with "no data" and any explanations for this lack of data should be entered in the "Notes" field of the corresponding section.
- All data reports must be submitted using the attached Excel worksheets. Include all data field headings (even if they have a blank entry) as they are listed in the attached Excel worksheets, and be sure that all data corresponds with its associated heading. Any time series data collected (e.g. flow, precipitation, etc.) should be submitted in a separate Excel worksheet for each site and the name of that worksheet should be reported in the appropriate "Time Series" field of the "Site Description" database. These worksheets may be bundled within a workbook.
- Please notify Caltrans of any errors or inconsistencies you find, or of any changes you might recommend.

Definition of a Precipitation Event

For purposes of these protocols, a precipitation event shall begin with six consecutive hours during which a sum total of 0.1 inches of rain falls and end with six consecutive hours in each of which no rainfall greater than 0.01 inches of rain is recorded. The precipitation event so identified shall be truncated so that it both begins and ends in hours with recorded rainfall greater than 0.01 inches.

With questions or comments, contact:

Andy Bale
Larry Walker Associates
(530) 753-6400 x30
andyb@lwadavis.com

List of Contents

1. SAMPLE DESCRIPTION

1.1. Contract Number

Example: 43A005
Definition: Caltrans contract number under which sample taken.

1.2. Task Order Number

Example: 11
Definition: Caltrans task order number under which sample taken.

1.3. Monitoring Site ID

Example: 7-124
Definition: A unique identification number assigned to the monitoring site by Caltrans.
Notes: The first part of this ID is the Caltrans district in which the site resides. Contact database manager for this number when first reporting site. This field is a reference to Site Description information.

1.4. Event ID

Example: 1997-3
Definition: Site-specific identification number of sampling event.
Notes: Format of this field is: year in which water year began-event number. This field is a reference to Event Description information.

1.5. Sample Source

Example: Storm
Definition: Identifies the source of the sample.
Notes: Standardized Entry. Enter name from standard list or notify database manager.

Standard List

- Storm - sample from stormwater runoff
- Rain - sample from rainwater
- Receiving - sample from receiving water
- Vadose - sample from vadose zone
- Soil - sample from soil
- Sediment - sample from deposited sediments
- Non-storm - sample from non-stormwater runoff
- Other - source described in notes.

1.6. Sample Matrix

Example: Water
Definition: Matrix from which sample collected.
Notes: Standardized Entry. Enter name from standard list or notify database manager.

Standard List

- Water
- Sediment
- Soil
- Solid
- Gas
- Other - sample matrix described in notes.

1.7. Constituent Type

Example: MIN
Definition: Describes the general type of constituent.
Notes: Standardized Entry. Enter name from standard list or notify database manager.

Standard List

- M - Metals
- N - Nutrients
- CON - Conventionals
- MIC - Microbial
- ORG - Organics
- P - Pesticides
- PCB - PCBs
- HC - Hydrocarbons
- MIN - Minerals
- OTH - Others

1.8. Constituent

Example: Cu
Definition: Name of constituent
Notes: Standardized Entry. Enter name from standard list or notify database manager.

Standard List

- See “Standard Constituent Names.”

1.9. Fraction

Example: Dissolved
Definition: Describes fraction reported.
Notes: Standardized Entry. Enter name from standard list or notify database manager.

Standard List

- Total
- TR - Total recoverable
- Diss - Dissolved

1.10. Extraction Method

Example: WET
Definition: Describes extraction method used.
Notes: Standardized Entry. Enter name from standard list or notify database manager.

Standard List

- DIWET - De-ionized Water Waste Extraction Test
- WET - Waste Extraction Test
- TCLP - Toxicity Characteristic Leaching Procedure
- SPLP - Synthetic Precipitation Leaching Procedure

1.11. Numerical Qualifier

Example: <
Definition: An indication of what the value represents (i.e. a minimum, maximum, or "exact" value).
Notes: Standardized Entry. Enter name from standard list or notify database manager.

Standard List

- < - actual value is less than reported value.
- = - value is as reported.
- > - actual value is greater than reported value.

1.12. Reported Value

Example: 2.5
Definition: Reported laboratory result.

1.13. Value Qualifier

Example: U
Definition: Qualifies reported value based on lab results and QA/QC analysis.
Notes: Standardized Entry. Enter name from standard list or notify database manager. Qualifiers are from USEPA CLP National Functional Guidelines for Organic Data (1994).

Standard List

- U - not detected above associated value. The associated value represents a detection limit that may be elevated due to blank contamination or matrix interference.
- J - associated value is approximate.
- N - constituent "tentatively identified."
- NJ - constituent "tentatively identified" and value is approximate.
- UJ - not detected above associated value. Associated value is approximate.
- R - results rejected because of QA/QC. Analyte may or may not be present.

1.14. Units

Example: mg/L
Definition: Describes the units of reported value.
Notes: Standardized Entry. Report in the units associated with this constituent in "Standard Constituent Names." Use capital "L" for liter abbreviation.

Standard List

- see "Standard Constituent Names."

1.15. Method Reference

Example: EPA
Definition: Provides the reference for the analysis method number.
Notes: Standardized Entry. Enter name from standard list or notify database manager.

Standard List

- EPA - US Environmental Protection Agency
- SM - Standard Methods
- Field
- Caltrans

1.16. Method Number

Example: 8140
Definition: Reference number of analysis method.

1.17. Method Detection Limit

Example: 0.2
Definition: Method detection limit.

1.18. Reported Detection Limit

Example: 1.0
Definition: Reported detection limit (RDL) as reported by lab. Equivalent to Practical Quantitative Limit (PQL).
Notes: The RDL may be elevated above the Caltrans "target" RDL due to matrix interference.

1.19. Collection Method

Example: Auto
Definition: Describes the way in which samples were collected..
Notes: Standardized Entry. Enter name from standard list or notify database manager.

Standard List

- Auto - automated
- Manual - manual

1.20. Sample Type

Example: C
Definition: Describes the way in which sample stream was represented.
Notes: Standardized Entry. Enter name from standard list or notify database manager.

Standard List

- C - composite
- G - grab

1.21. Event Representation

Example: FF
Definition: Describes the part of event represented by sample.
Notes: Standardized Entry. Enter name from standard list or notify database manager. Fill in only if estimate is based on actual runoff data.

Standard List

- FF - Event first flush
- Peak - Event peak flow
- Whole - Whole storm
- Discrete - One of a set of discrete samples
- Other - explain in notes

1.22. Field Sample ID

Example: DB43099
Definition: Field identification number of sample.

1.23. Sample Start Date

Example: 4/25/1999
Definition: Date on which composite begins or grab collected.
Notes: Formatted as mm/dd/yyyy.

1.24. Sample Start Time

Example: 14:24
Definition: Time at which composite begins or grab collected.
Notes: Formatted for 24-hour clock (hh:mm).

1.25. Sample End Date

Example: 4/25/1999
Definition: Date on composite ends.
Notes: Formatted as mm/dd/yyyy. Leave blank for grabs.

1.26. Sample End Time

Example: 14:24
Definition: Time at which composite ends.
Notes: Formatted for 24-hour clock (hh:mm). Leave blank for grabs.

1.27. Lab Name

Example: APPL
Definition: Name of lab which analyzed sample.
Notes: Standardized Entry. Enter name from standard list or notify database manager.

Standard List

- ABC
- APPL
- Aquascience
- BC
- Cal Science
- Chromalab
- CLS
- Del Mar Analytic
- Kinnetics
- Montgomery Watson
- North Coast
- Pace Analytical
- Pat-Chem
- Quality Analytical
- Quanterra
- Sequoia
- ToxScan
- UCD
- UCLA
- Other - Explain in Notes and notify database manager.

1.28. Lab Sample ID

Example: L14981-001
Definition: Identification number assigned to sample by lab.

1.29. Notes

Definition: Any notes or remarks about the sample or sample data.

2. SAMPLING EVENT DESCRIPTION

Note: See "Definition of a Precipitation Event" in "General Instructions."

2.1. Event ID

Example:	1997-3
Definition:	Site-specific identification number of sampling event.
Notes:	Format of this field is: year in which water year began-event number.

2.2. Monitoring Site ID

Example:	7-124
Definition:	A unique identification number assigned to the monitoring site by Caltrans.
Notes:	The first part of this ID is the Caltrans district in which the site resides. Contact database manager for this number when first reporting site. This field is a reference to Site Description information.

2.3. Event Start Date

Example:	4/25/1999
Definition:	Date of arrival at sampling site.
Notes:	Formatted as mm/dd/yyyy.

2.4. Event Start Time

Example:	15:10
Definition:	Time of arrival at sampling site.
Notes:	Formatted for 24-hour clock (hh:mm).

2.5. Rain Start Date

Example:	4/25/1999
Definition:	Date precipitation event begins.
Notes:	Formatted as mm/dd/yyyy.

2.6. Rain Start Time

Example:	14:24
Definition:	Time precipitation event begins.
Notes:	Formatted for 24-hour clock (hh:mm).

2.7. Rain End Date

Example:	4/26/1999
Definition:	Date precipitation event ends.
Notes:	Formatted as mm/dd/yyyy.

2.8. Rain End Time

Example:	1:34
Definition:	Time precipitation event ends.
Notes:	Formatted for 24-hour clock (hh:mm).

2.9. Event Rain (in)

Example: 0.62
Definition: Total rain at site for event in decimal inches to two (2) decimal places. See "Nearest Rain Gauge" in "Site Description" for source.

2.10. Max Intensity (in/hr)

Example: 0.14
Definition: Maximum hourly intensity of storm in decimal inches to two (2) decimal places.

2.11. Antecedent Dry (days)

Example: 12.3
Definition: Days since end of last precipitation event in decimal days to one (1) decimal place.
Notes: See "Definition of a Precipitation Event" in "General Instructions."

2.12. Antecedent Rain (inches)

Example: 0.53
Definition: Total rain at site for antecedent precipitation event in decimal inches to two (2) decimal places.
Notes: See "Definition of a Precipitation Event" in "General Instructions."

2.13. Peak Capture

Example: Y
Definition: Indication of whether peak flow captured during event.
Notes: Standardized Entry.

Standard List

- Y - Peak flow captured.
- N - Peak flow not captured.

2.14. Runoff Start Date

Example: 4/25/1999
Definition: Date of first runoff.
Notes: Formatted as mm/dd/yyyy.

2.15. Runoff Start Time

Example: 14:24
Definition: Time of first runoff.
Notes: Formatted for 24-hour clock (hh:mm).

2.16. Runoff End Date

Example: 4/25/1999
Definition: Date of last runoff from this precipitation event.
Notes: Formatted as mm/dd/yyyy.

2.17. Runoff End Time

Example: 14:24
Definition: Time of last runoff from this precipitation event.
Notes: Formatted for 24-hour clock (hh:mm).

2.18. Total Flow Volume (ft3)

Example: 3280
Definition: Total measured flow volume at sample site for this event. Reported as integer.

2.19. Peak Flow (cfs)

Example: 14.5
Definition: Estimated peak flow of runoff for this event to one (1) decimal place.

2.20. Estimated % Capture

Example: 71
Definition: Estimated percentage of total flow volume captured to two (2) significant digits. Fill in only if estimate is based on actual runoff data.

2.21. Cumulative Precip (in)

Example: 12.22
Definition: Estimated cumulative precipitation at sampling site since beginning of water year (October 1). Report to two (2) decimal places.

2.22. Collection by

Example: Juanita Merganser
Definition: Name of individual by whom samples collected.

2.23. Organization

Example: Quack & Quack Sampling
Definition: Name of organization by which sample collector employed.

2.24. Notes

Definition: Any notes or remarks about the event or event data.

3. SITE DESCRIPTION

3.1. Monitoring Site ID

Example: 7-124
Definition: A unique identification number assigned to the monitoring site by Caltrans.
Notes: The first part of this ID is the Caltrans district in which the site resides. Contact database manager for this number when first reporting site.

3.2. Site Name

Example: Brown Rd Detention Basin
Definition: Name of site.

3.3. Caltrans District

Example: 7
Definition: Caltrans district in which sampling site resides.

3.4. Hydrologic Sub-area

Example: 403.25
Definition: California Department of Water Resources (DWR) Hydrologic Unit sub-area in which monitoring site resides.
Notes: Hydrologic sub-areas are typically identified in Basin Plans. They may also be found by querying the Caltrans Water Quality Objective database at: http://endeavor.des.ucdavis.edu/wqsid/wqodbase.htm

3.5. County

Example: Los Angeles
Definition: County in which sampling site resides.

3.6. RWQCB

Example: 4
Definition: Regional Water Quality Control Board (RWQCB) region in which sampling site resides.

3.7. Type of Site

Example: Fwy
Definition: Character of area tributary to this sampling location or BMP.
Notes: Standardized Entry. Enter name from standard list or notify database manager.

Standard List

- Hwy - Highway
- Fwy - Freeway
- Maintenance - Maintenance facility
- Bridge - Bridge
- Parking - Parking lot (e.g. Park & Ride)
- Construction - Construction site
- BMP - Site designed for stormwater treatment
- Receiving - Receiving water (described in "Receiving Water Type")

3.8. Catchment Descriptor

Example: Landscape
Definition: Describes the tributary catchment area.
Notes: Standardized Entry. Enter name from standard list or notify database manager.

Standard List

- Landscape - Landscaping
- Pavement - Pavement only
- Right-of-Way - Caltrans right-of-way (Landscape and pavement)
- Watershed - Municipal or rural watershed
- Other - Explain in Notes and contact database manager.

3.9. Land Use

Example: O
Definition: Predominant land use of the tributary catchment area.
Notes: Standardized Entry. Enter name from standard list or notify database manager.

Standard List

- R - Residential
- C - Commercial
- I - Industrial
- A - Agriculture
- F - Forest
- O - Open
- T - Transportation Facility (e.g. bridge, roadway, etc.)

3.10. Catchment Area (acres)

Example: 1.5
Definition: Total surface area draining to point of collection, reported to one (1) decimal place.

3.11. Impervious Fraction

Example: 0.6
Definition: Estimated fraction of the catchment area that is effectively impervious, reported to one (1) decimal place.

3.12. BMP Type

Example: Wet Pond
Definition: Describes the extent of characterization or type of BMP.
Notes: Standardized Entry. Enter name from standard list or notify database manager. Leave blank if site is not a BMP.

Standard List

- Retention - Retention pond
- Ditch - Ditch
- Swale - Biofiltration Swale
- EDB - Extended detention basin
- Wet Pond - Wet detention pond
- Dry Pond - Extended dry detention pond
- Compost - Compost media filter
- SF - Sand media filter
- IB - Infiltration basin
- IT - Infiltration trench
- TCB - Trapping catch basin
- Insert - Drain inlet insert
- Strip - Biofiltration strip
- Strip-Trench - Filtration strip and infiltration trench treatment train
- OWS - Oil / water or debris separator
- MCTT - Multi-chambered treatment train
- CDS - Continuous deflector separator
- Other - Explain in Notes and contact database manager.

3.13. Point of Collection

Example: Inlet
Definition: Describes the point of collection represented by this site.
Notes: Standardized Entry. Enter name from standard list or notify database manager.

Standard List

- Inlet - Inlet to BMP
- Outlet - Outlet from BMP
- Within - Somewhere within a BMP
- Discharge - Discharge to receiving waters or conveyance system
- Overland - Overland flow
- Receive - Representative location(s) in receiving water stream or lake

3.14. Cut-Fill

Example: Cut
Definition: Identifies the roadway or facility as a cut or fill site.
Notes: Standardized Entry. Enter name from standard list or notify database manager.

Standard List

- Cut - sample from a cut area
- Fill - sample from a fill area
- Grade - sample from grade area

3.15. Post Mile

Example: SR-10-24.3
Definition: Roadway number and post mile.
Notes: Include if site is a roadway. Format is: type-roadway number-post mile. Enter "type" from standard list or notify database manager.

Standard List

- I - Interstate
- SR - State Route
- CR - County Road

3.16. Latitude

Example: 38.24358
Definition: Latitude in decimal degrees to five (5) decimal points.

3.17. Longitude

Example: 121.32122
Definition: Longitude in decimal degrees to five (5)) decimal points.

3.18. Rain Record Source

Example: NOAA Etiwanda
Definition: Source of precipitation record used in estimates.
Notes: Report "onsite" if rain gauge is on site, the name of the nearest rain gauge, or "other." If "other," explain in notes. Include record in separate worksheet (see "Time Series" in this data section.

3.19. Receiving Water Type

Example: River
Definition: Type of receiving water sampled or into which site discharges.
Notes: Standardized Entry. Enter name from standard list or notify database manager.

Standard List

- Intermittent - Intermittent or seasonal stream or channel
- Wetlands - Seasonal or perennial wetlands
- River - Perennial freshwater river
- Stream - Perennial freshwater stream
- Lake - Freshwater lake or impoundment
- Pond - Freshwater pond
- Bay - Salt or brackish water bay
- Estuary
- Ocean

3.20. ADT (cars/day)

Example: 4590
Definition: Average daily traffic flow at, or near, monitoring site.

3.21. ADT Source

Example: Caltrans DOC# STMP-098-077
Definition: Source or reference for reported ADT value.

3.22. Time Series

Example:	Caltrans.xls:BrownRd
Definition:	The Excel worksheet in which time series data (flow, precip, etc.) collected for this site is submitted.
Notes:	All time series data collected should be submitted in a separate Excel worksheet for this site. Site worksheets may be bound together in a single workbook (optional). Format is "TheWorkbook:TheWorksheet." Data should be submitted in columns with date:time in the first column.

3.23. Site Description

Example:	Oceanside with rolling hills.
Definition:	Site observations and miscellaneous details.

3.24. Notes

Definition: Any notes or remarks about the site or site data.

4. STANDARD CONSTITUENT NAMES

4.1. Metals (ug/L, typ.)

Al	Pb
Sb	Mg
As	Hg
Be	Ni
Cd	Se
Cr	Ag
Cr (III)	Tl
Cr (VI)	Zn
Cu	Fe

4.2. Nutrients (mg/L, typ.)

NH3-N	Ortho-P
NO2-N	P
NO3-N	TKN

4.3. Conventionals (mg/L, typ. unless noted)

Alkalinity as CaCO3	K
B	Mn
Ba	Na
BOD	pH (pH units)
Ca	Salinity
Chlorine Residual	Silica
Cl	SO4
CO3	TDS
COD	Temperature (°C)
DO	TOC
EC (umhos/cm)	TSS
F	Turbidity (NTU)
Hardness as CaCO3	TVSS
HCO3	

4.4. Microbiological (MPN/100 mL, typ.)

Cryptosporidium	Fecal Sterol
E-Coli	Fecal Strep
Fecal Coliform	Giardia
Fecal Enterococci	Total Coliform

4.5. VOCs (EPA 8260, 601, 602, 603; ug/L, typ.)

Acetone
Acrolein
Acrylonitrile
Benzene
Bromobenzene
Bromochloromethane
4-Bromofluorobenzene
Bromoform
2-Butanone (Methyl ethyl ketone)
Carbon Tetrachloride
Chlorobenzene
Chlorodibromomethane
Chloroethane
2-Chloroethylvinyl ether
Chloroform
1,2-Dibromo-3-chloropropane
1,2-Dibromoethane
Dibromomethane
Dibromofluoromethane
1,2-Dichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
Dichlorobromomethane
Dichlorodifluoromethane
1,1-Dichloroethane
1,2-Dichloroethane
1,1-Dichloroethylene
cis-1,2-Dichloroethene
1,2-Trans-Dichloroethylene
1,2-Trans-Dichloroethylene
1,2-Dichloropropane
cis-1,3-Dichloropropene
trans-1,3-Dichloropropene
1,3-Dichloropropylene
Ethanol
Ethylbenzene
2-Hexanone
Isopropylbenzene
Methanol
Methyl-t-butyl ether (MTBE)
Methyl Bromide
Methyl Chloride
Methylene Chloride
4-Methyl-2-pentanone (MIBK)
Styrene
1,1,1,2-Tetrachloroethane
1,1,2,2-Tetrachloroethane
Tetrachloroethylene (PCE)
Toluene
1,1,1-Trichloroethane
1,1,2-Trichloroethane
Trichloroethylene (TCE)
Trichlorofluoromethane
Vinyl acetate
Vinyl Chloride
o-Xylene
m-Xylene
p-Xylene
Xylenes (total)

4.6. SVOCs (EPA 8250/8270, 625; ug/L, typ.)

Acenaphthene
Acenaphthylene
Anthracene
Aniline
Benzidine
Benzo(a)Anthracene
Benzo(a)Pyrene
Benzo(b)Fluoranthene
Benzo(ghi)Perylene
Benzo(k)Fluoranthene
Benzoic acid
Benzyl alcohol
Bis(2-chloroethoxy)Methane
Bis(2-chloroethyl)Ether
Bis(2-chloroisopropyl)Ether
Bis(2-Ethylhexyl)Phthalate
4-Bromophenyl Phenyl Ether
Butylbenzyl Phthalate
Carbazole
4-Chloroaniline
2-Chloronaphthalene
2-Chlorophenol
4-Chlorophenyl Phenyl Ether
Chrysene
Dibenzo(a,h)Anthracene
Dibenzofuran
Di-n-Butyl Phthalate
1,2-Dichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
3,3 Dichlorobenzidine
2,4-Dichlorophenol
2,6-Dichlorophenol
Diethyl Phthalate
Dimethyl Phthalate
2,4-Dimethylphenol
Pentachlorophenol
2-Methyl- 4,6-Dinitrophenol
2,4-Dinitrophenol
2,4-Dinitrotoluene
2,6-Dinitrotoluene
Di-n-Octyl Phthalate
1,2-Diphenylhydrazine
Fluoranthene
Fluorene
Hexachlorobenzene
Hexachlorobutadiene
Hexachlorocyclopentadiene
Hexachloroethane
Indeno(1,2,3-c,d)Pyrene
Isophorone
2-Methylnaphthalene
2-Methylphenol (o-Cresol)
3-Methylphenol (m-Cresol)
4-Methylphenol (p-Cresol)
3-Methyl 4-Chlorophenol
Naphthalene
2-Nitroaniline
3-Nitroaniline
4-Nitroaniline
Nitrobenzene
2-Nitrophenol
4-Nitrophenol
N-Nitrosodimethylamine
N-Nitrosodi-n-Propylamine
N-Nitrosodiphenylamine
Phenol
Phenolics
Phenanthrene
Pyrene
1,2,4-Trichlorobenzene
2,4,5-Trichlorophenol
2,4,6-Trichlorophenol

4.7. OC Pesticides (EPA 8080/8081; ug/L, typ.)

Aldrin
Arochlor 1016
Arochlor 1221
Arochlor 1232
Arochlor 1242
Arochlor 1248
Arochlor 1254
Arochlor 1260
alpha-BHC
beta-BHC
gamma-BHC
delta-BHC
Chlordane
alpha-Chlordane
gamma-Chlordane
4,4'-DDT
4,4'-DDE
4,4'-DDD
Dieldrin
alpha-Endosulfan
beta-Endolsulfan
Endosulfan Sulfate
Endrin
Endrin Aldehyde
Heptachlor
Heptachlor Epoxide
Methoxychlor
PCBs (total)
Toxaphene

4.8. OP Pesticides (EPA 8140/8141; ug/L, typ.)

Azinphos methyl
Bolstar (Sulprofos)
Disyston
Chlorpyrifos
Coumaphos
Def
Demeton-O and S
Diazinon
Dichlorvos
Dimethoate
Diphenamid
Disulfoton
Ethion
Ethoprop
Fensulfothion
Fenthion
Malathion
Merphos
Methidathion
Methyl trithion
Mevinphos
Naled
Parathion, ethyl
Parathion, methyl
Phorate
Phosalone
Phosmet
Prometon
Prowl
Ronnel
Stirophos (Tetrachlorvinphos)
Simazine
Tokuthion (Prothiofos)
Trichloronate
Trifluralin

4.9. Other Pesticides (EPA 8150; ug/L, typ.)

2,4,5-T
2,4,5-TP (Silvex)
2,4-D
2,4-DB
Dicamba
Dichloroprop
Dinoseb (DNBP)
MCPA

Dalapon	MCPP

4.10. Misc. Other Pesticides (ug/L, typ.)

Bromacil	Isoxaben
Cacodylic Acid	Mefluidide
Chlorsulfuron, Sulfometuron-methyl	Oryzalin
Diquat	Oxadiazon
Diuron	Oxytlurfen
Fluozifop-p-butyl	Trichlopyr
Glyphosphate	

4.11. Hydrocarbons (mg/L, typ.)

BTEX	TPH (Gasoline)
Oil & Grease	TPH (Heavy oil)
MTBE	TPH (Motor oil)
TEPH	TRPH
TPH (Diesel)	TVPH

4.12. Other (mg/L, typ. unless noted)

Asbestos (fibers/L)	DOC
Chlorophyll-a	MBAS
Cyanide	2,3,7,8 Tetrachloro-dibenzo-p-dioxin (ug/L)

5. RELEASE CHANGES

Changes in the Data-reporting Protocols since the 3/5/99 (first) release.

3.4. Hydrologic sub-area	change date
• Appended "Notes" that read: Hydrologic sub-areas are typically identified in Basin Plans. They may also be found by querying the Caltrans Water Quality Objective database at: http://endeavor.des.ucdavis.edu/wqsid/wqodbase.htm	3/26/99
3.12. BMP Type	
• Changed the name "CBI" in the standard list to "Insert," and change its definition from "Catch Basin Insert" to "Drain Inlet Insert."	3/14/99
• Changed the name "MCIT" to "MCTT" in the standard list.	3/15/99
3.16. Latitude & 3.17. Longitude	
• Appended both definitions to read "…in decimal degrees to five (5) decimal points."	3/15/99

Appendix F
Estimating Pollutant Loadings and BMP Efficiency

Estimating Pollutant Loadings and BMP Efficiency

Background

This section provides a brief literature review and background information on constituent loading calculation and estimation techniques which were used in selecting the appropriate methods for analyzing data obtained from the BMP monitoring program. Several documents outlining constituent load estimation methods and/or related topics were reviewed. The techniques are generally very similar, and a few representative documents will be briefly discussed here. Summaries from a few key studies are also provided.

The EPA's Nationwide Urban Runoff Program (1982) measured constituent concentrations at 85 sites for 200 storms throughout the United States, and the results were published in 1983. This study is probably the most comprehensive study of its type available. The study began by testing the assumed log-normal distribution of the data, which was determined to be valid. Site-specific rainfall/runoff characteristics were found to be very important to the results. Federal Highway Administration (FHWA) has outlined a procedure for estimating impacts to streams and lakes receiving highway stormwater runoff in a three volume report entitled as, "Pollutant Loadings and Impacts from Highway Stormwater Runoff" (1990). Volume III of the report, entitled as "Analytical Investigation and Research Report", tested the validity of the lognormal distribution, which is then used in presenting the methodology used in data analysis. Results indicated that when an underlying population has a lognormal distribution, the mean and variance of the population should be obtained by computing the mean and standard deviation of the logarithmic transforms of the data.

Volume I of the FHWA 1990 report, entitled as "Design Procedure", provides worksheets to calculate runoff and constituent loading parameters from inputs such as drainage area, rainfall data, streamflow, Event Mean Concentration (EMC), and soluble fractions (defined as soluble fraction of each measured constituent). One worksheet is provided to calculate runoff from the site characteristics, and another is given to calculate constituent mass load in pounds per year from highway runoff characteristics. The annual mass load is computed according to the following equation:

$$AML = EMC * MVR * N * 0.00006245$$

where: AML is the annual mass load in pounds per year,
EMC is the event mean concentration in mg/L,
MVR is the mean volume of runoff from a storm event at the specified site in cubic feet,
N is the average number of storms per year,
0.00006425 is a conversion factor to convert results to annual mass in pounds per

year,

The Flint Creek Watershed Project (1995) was initiated by the Morgan County Soil and Water Conservation District to improve and protect the water quality of Flint Creek, located in Northwestern Alabama. To determine the best approach, annual constituent loadings were estimated for Total Suspended Solids, BOD5, Total Kjedahl Nitrogen, Phosphorous, and Nitrogen for land uses including, industrial and commercial, residential, cropland, pasture, and grazing type uses. For industrial and commercial land uses, the following equation was used to estimate annual constituent loads:

$M = R * K * A * C * 0.227$

where: M = Constituent Loading (lbs/yr)
R = Rainfall (in/yr)
K = Runoff Coefficient
A = Drainage Area (acres)
C = Pollutant Concentration in Runoff (mg/L)
0.227 = Unit Conversion Factor

The Santa Monica Bay Restoration Project included annual estimates of constituent loading to Santa Monica Bay from stormwater runoff. The constituent loadings were tabulated for various land uses, including residential, commercial, industrial, and open spaces. Water quality measurements were taken at 22 selected locations. Pollutant loads were obtained by multiplying the stormwater flow rate by a constituent concentration. The runoff is affected by land use, so the following load estimating model was used to account for variation in land use:

$$\text{Load} = \Sigma M_a * X_a$$

where: M is concentration of constituents for land use a, and X is runoff from land use a.

Finally, in review of the "1996-1997 Caltrans Detention Basin Monitoring Plan", NRDC outlined a loading estimation method which is very similar to the FHWA method discussed above and recommended to arrange the loading calculations on one or more computerized spreadsheets for convenience (November 12, 1996 Memorandum from Richard Horner to Ed Dammel and Bob Smith). The recommended method can be used to estimate wet season and annual loading given calculated event loadings. If possible, NRDC suggested to obtain continuously recorded local flow data and a series of representative local EMC readings. Assuming log-normal distribution of EMCs, the mean of the EMCs can be calculated using an applicable statistical relationship. In addition to the constituent load estimations, NRDC recommended that BMP efficiencies be evaluated from a comparison of effluent and influent loadings (over a period of time) from the following relationship:

Efficiency (%) = [(Loading in - Loading out)/Loading in] x 100

Methodology

The recommended methodology for estimating effluent and influent constituent loadings for the subject detention basins was obtained from FHWA report *Pollutant Loadings and Impacts from Highway Stormwater Runoff*. This method is very similar to the NRDC recommended procedure discussed above. Caltrans and NRDC acknowledge the limitations of the procedure when it is applied to small data sets. Statistical analysis will be performed for each year of the program and for the overall monitoring period of two years. Other numerical techniques will be employed as needed to make the most effective use of the data set.

Estimating Pollutant Loading

The following is a step-by-step guide in estimating constituent loadings using the FHWA method:

1. Collect stormwater runoff samples from representative storms.

2. Analyze water samples for desired water quality parameters and obtain EMCs.

3. Tabulate EMCs.

4. Measure runoff volume per storm. If problems occur with obtaining flow data, multiply runoff coefficient (unitless) by watershed area (in acres) and rainfall depth per storm (in inches) to obtain runoff volume (acre-in).

5. Convert runoff volume from acre-in to liters using the conversion factor: acre-in = 102,790 liters.

For single event constituent loading calculation, perform Steps 6a and 7a, otherwise skip to Step 6b:

6a. Multiply EMCs (in *m*g/l or mg/l) from Step 2 by runoff volume (in liters) from Step 5 to obtain constituent load in *m*g or mg.

7a. Convert constituent load from *m*g or mg to pounds (lbs) using the conversion factors: 1 mg = 0.00220 lbs and 1 *m*g = 0.00000220 lb.

For average wet season loading estimations, perform Steps 6b and 7b:

6b. Take natural log of EMCs from Step 2.

7b. Compute mean *(m)* and variance *(s^2)* of natural logs obtained from Step 6b from the following equations:

$$m = \frac{\sum x}{n}$$

$$s^2 = \frac{\left(n\sum x^2 - \left(\sum x\right)^2\right)}{n(n-1)}$$

where: x is the natural log of EMCs.
Sx represents the summation of data points (x).
n is the number of data points (x).

8. Compute expected value *a* (also known as mean of the EMC) using the following formula:

$$a = e^{(m + s^2/2)}$$

9. Compute upper and lower confidence limits x_{hi} and x_{lo} from *m*, *s*, and standardized normal deviate, *z*, using the equation:

$$x = e^{(m +/- zs)}$$

The value of *z* corresponds to a given probability of exceedence, which can be converted to a confidence level. For a confidence level of 90%, for example, the *z* value corresponding to 0.90 is 1.28. Values for *z* can be obtained from a standard normal distribution table.

10. Compute runoff volume per wet season by multiplying runoff coefficient (unitless) by watershed area (in acres) and rainfall depth per wet season (in inches) to obtain runoff volume (acre-in), and converting to liters by using the conversion factor from step 5 above.

11. To obtain expected constituent load in the wet-season, multiply expected value (mean of the EMC) from Step 8 by the runoff volume obtained from Step 10. Convert to pounds (lbs) using the conversion factor provided in Step 7a.

12. To obtain the 90% confidence limits for expected constituent loadings in the wet-season, repeat Step 11, substituting the confidence limits from Step 9 for the expected value.

Computing BMP Efficiency

As mentioned previously, BMP (detention basin and CSF) efficiencies may be evaluated by comparing effluent and influent loadings over the entire wet season from the following equation:

$$\text{Efficiency (\%)} = [(\text{Loading in} - \text{Loading out})/\text{Loading in}] \times 100$$

For the detention basins, since the residence times are expected to be fairly long (longer than a typical event duration), cumulative loadings over a series of events should be used in estimating BMP efficiency. When using a multiple events for basin efficiency calculations, it is necessary to have a complete loading record or representative loadings. Since the CSF residence times are expected to be fairly short and the CSFs should be operating under steady state conditions, the EMC (or the mean EMC for a series of events) can be substituted for loading in the efficiency equation above.